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Abey, A.E., Apparatus for deformation tests at intermediate strain rates—10^{-2} to 10^{-3} s^{-1}—and at high pressure, 3:1118 (UCRL-79012)
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Volume 3, Number 5, March 15, 1978

ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

REFER ALSO TO CITATION(S) 10601

9530 **Coal. Part II. Scientific and technical aspects.** Hawley, M.E. (ed.). New York; Halsted Press (1976). 434p. .

A broad view of coal technology is presented with the emphasis on the science and engineering that are unique to coal and on the contributions that coal investigators have made to those topics in mining and preparation engineering which are common to both coal and ores. These common topics, such as ventilation, pumping, lighting, and boring, are treated more briefly than such topics as blasting, cutting, loading, and continuous miners, all of which have characteristics peculiar to coal. Sections are included on classification of coal, coal resources, coal preparation transportation, combustion and conversion to liquids. (JRD)

PROCESSING

REFER ALSO TO CITATION(S) 9640, 11408

9531 (FE—2433-12) **Environmental assessment of the HYGAS process. Quarterly progress report No. 3, January 1—March 31, 1977.** (Institute of Gas Technology, Chicago, Ill. (USA)). Oct 1977. Contract EX-76-C-01-2433. 32p. Dep. NTIS, PC A03/MF A01.

A revised and enlarged test plan for the environmental assessment program was developed and a draft was circulated to interested parties for review and comment. The compositions of water streams during Test 59 with bituminous coal were obtained for 3 days of plant operation; large fluctuations in contaminant levels reflected operating difficulties encountered during this test. The bituminous coal feed for test 59, with 4.5 weight percent sulfur, had the highest level of sulfur yet encountered. Some sulfur was released during the oxidative coal pretreatment step, primarily from the organic sulfur species. Trace element data were obtained during Test 55 and compared with earlier IGT work performed in a process development unit with lignite coal. Data from the two units show substantial differences for iron, barium, molybdenum, nickel, zinc, chromium, lead, and mercury. Relatively good agreement was obtained for manganese, lithium, boron, and cadmium. The expected trace element compounds in the HYGAS reactor are reported from preliminary thermodynamic analyses performed in the PDU study. Relationships were sought between sets of two aromatic components in the coal feed oil slurry and in oil recovered from the steam stripper. Several trial runs were made in the laboratory to determine the effects of shift catalysts on pollutant levels in simulated process gas mixtures. The results of a time-series sampling of the product-gas quench condensate carried out during Test 57 were analyzed statistically and used to predict the expected error in the HYGAS batch-sampling scheme for quench condensate. Based on these results, the current HYGAS sampling scheme seems reasonable, because longer time periods increase the risk of encountering unsteady-state periods, and shorter time periods are operationally and economically prohibitive.

9532 **Fuel composition and method of manufacture.** Keller, L.J. (to Keller Corp.). US Patent 4,045,092. 30 Aug 1977. Filed date 22 Sep 1975. 16p.

An economical fuel composition is presented that can be readily transported and stored and that has good nonpollution properties characterized by a combustible, pseudo-thixotropic, liquid-solid suspensoid including a critical proportion of coal particles having a critical settling velocity substantially uniformly dispersed in a solution of methyl fuel including methanol, water and other alcohol-soluble constituents of the coal. The critically sized and shaped coal particles are worked in the presence of the methyl fuel to become wet along all surfaces, such that the coal particles are maintained in suspension by even low intensity stirring in storage and do not separate out upon flow through a pipe line. The suspensoid has shear thinning rheological properties so as to be pumpable with a lower apparent viscosity than its at-rest viscosity.

CARBONIZATION

9533 (NBS-SP—468, pp 131-134) **Steel plant coke ovens: an energy conversion process with warpage problems.** Lownie, H.W. Jr.; Hoffman, A.O. (Battelle Columbus Labs., Columbus, OH). Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

A brief discussion of the warpage problems existing in the armour of steel plate coke-ovens and the proposed research to develop upgraded designs/materials to eliminate these problems are presented.

9534 (NP—21795) **Cleaning of charging gas in coking plants using the Saarberg—Hoelter system.** Leibrock, K.; Esche, M. (Saarberg-Hoelter Umwelttechnik G.m.b.H., Saarbruecken (Germany, F.R.)). 1975. 11p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Charging gases are formed in coking plants when the damp coal, with approximately 10 percent water, comes into contact with the hot oven walls, whose temperature exceeds 1,000°C. They consist mainly of distillation gases, water vapour, tar mist, entrained coal dust and soot; the composition as well as the quantity of these gases changes continually, both in the stamping and in the customary gravity charging process. The temperature of the charging gases can reach a maximum of 650°C. In both coking systems, the charging gases escape through the open charging holes, ascension pipes, and in the stamping process, also through the coke oven door on the machine side, and in some plants, through the shield hole. To lower pollution of the coking plant itself, and of the environment, in a really effective manner, the charging gases—which are formed when filling the coke oven chamber—must be completely drawn off, as far as this is feasible, and freed from harmful substances. Tests showed that it was necessary to burn the tar mist contained in the charging gases. Combustion control problems are avoided by using a combustion chamber of sufficient size with a fire brick lining (to retain the heat) so that controlled combustion without soot formation is obtained. The flue gas is cooled with a fine water spray to about 70°C, scrubbed in a proprietary "ROTOVENT" venturi scrubber and drawn off into the atmosphere with an electric fan. All this equipment has been mounted in a charging gas cleaning car movable from oven to oven. The required emission values have been attained. (LTN)

9535 **Apparatus for transferring hot coke into a coke quenching car.** Gidick, W.F. (to Koppers Co., Inc.). US Patent 4,053,068. 11 Oct 1977. Filed date 30 Aug 1976. 8p.

Associated with a coke quenching car, preferably a one-spot car, is a coke guide that carries a distributor trough. The distributor trough is pivotably mounted so that when the coke guide is racked out to transfer coke into the quenching car, the distributor is positioned to transfer the coke further out into the car and to better distribute the coke in the car.

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 9543, 9548, 9591, 9649

9536 (EPRI-AF—508) **Magnetic separation of mineral matter from coal liquids. Final report.** (Massachusetts Inst. of Tech., Cambridge (USA). Francis Bitter National Magnet Lab.; General Electric Co., Schenectady, N.Y. (USA)). Aug 1977. 104p. Dep. NTIS, PC A06/MF A01.

Successful removal of inorganic sulfur from solvent refined coal by high gradient magnetic separation has been demonstrated. At the optimum temperature the inorganic sulfur removal was comparable with that achieved by mechanical filtration, estimated at 99%; 20 to 40 percent of the ash was removed. The solids reduction is critically dependent on the temperature with maximum reduction at 430°F, where the magnetization of the filter cake solids exhibits a local maximum. Most of the tests were conducted at a magnetic field strength of 20 kOe and at flow velocities up to 3 cm/s. There appears to be no velocity dependence in this range. Performance is improved at higher field strengths (fields up to 80 kOe were investigated) and the temperature dependence is somewhat moderated. Preliminary tests on backwashing trapped solids from the matrix show 90 to 98 percent removal of the trapped solids and no significant build-up of residual solids on cyclic reuse of the matrix. A study was undertaken to investigate the thermal and controlled atmosphere pretreatment of coal liquefaction residual solids to enhance their magnetic separability. Magnetization enhancement at practical process temperatures of a factor of 4 to 10 has been achieved.

9537 (FE—2033-19(Vol.2)) **Hot low Btu producer gas desulfurization in fixed bed of iron oxide-fly ash. Final report, 1 July 1975—30 April 1977. Volume II. Appendices A, B, C, D, and E.** Joshi, D.K.; Leuenberger, E.L. (Air Products and Chemicals, Inc., Marcus Hook, Pa. (USA)). Sep 1977. Contract EX-76-C-01-2033. 356p. Dep. NTIS, PC A16/MF A01.

This volume contains appendices as follows: a description of the ERDA pressure unit; derivation of differential equations describing sorption and regeneration dynamics; computer program for process simulation and data. (LTN)

9538 **Process for reducing the sulfide sulfur content of char with carbon dioxide and H_2O.** Robinson, L.; Sass, A. (to Occidental Research Corp.). US Patent 4,053,285. 11 Oct 1977. Filed date 15 Jan 1976. 8p.

This invention covers a process for reducing the sulfide sulfur content of char by treatment with a gaseous mixture of carbon dioxide and H_2O.

9539 **Chemistry of selective oxidation of sulfur compounds and its relation to fuel desulfurization.** Attar, A. Pasadena, CA; California Institute of Technology (1977). vp. Microfilms.

Thesis (Ph. D.).

An alternative method to desulfurize fossil fuel is proposed. There are two steps in the method: (1) selective oxidation of the sulfur compound to the corresponding sulfoxide (I) and sulfone (II), and (2) pyrolysis of the product to a hydrocarbon and sulfur dioxide. The critical step is the selective oxidation of the sulfur compound to I and II. This oxidation was carried out by peroxides that were formed in situ when a hydrocarbon solution of the sulfide was oxidized with molecular oxygen in the presence of a catalyst like HBr, at 140 to 160°C. Butyl sulfide was used as a model sulfur compound and toluene and tetralin in bromobenzene were used to simulate the organic medium. The most important results are: (1) In the absence of HBr the oxidation proceeds to the sulfoxide only, but when HBr is present also sulfone is found. (2) HBr increases the rate of oxidation of the hydrocarbon and the reactivity of free radicals.

9540 (ORNL-tr—4330) **Reduction of the sulfur content in coals.** Kaminskii, V.S.; Yagodkina, T.K. Translated by L. Kobylenski from *Tr. Inst. Obogashch. Tverd. Goryuch. Iskop.;* **4**: No. 1, 80-94(1975). 19p. Dep. NTIS, PC A02/MF A01.

Most of the low sulfur coal deposits are in the Asian part of the Soviet Union, while the major industrial coal mining is in the European areas where more than half the coal contains more than 2.5 percent sulfur. This article examines only the desulfurization of coking coal during beneficiation. The possibility of removing sulfur depends upon a series of factors. The main ones are: the average amount of sulfur in coal; the relationship between different types of sulfur; the nature of iron disulfide dispersement; the physical/chemical characteristics of iron disulfides (porosity, hardness, electric conductivity, magnetic susceptibility, degree of contamination by different impurities, crystalline structure, etc); distribution of sulfur by density and thickness; and the technology applied in coal beneficiation plants. Various methods of reducing the sulfur content of coal have been studied and compared: Concentrating tables; centrifugal separation in heavy media and aqueous media; cyclones; hydroclones; magnetic separation, including thermomagnetic preparation; flotation; and microbiological oxidation of pyrite. In most cases, the desulfurization obtained was only partial (20 to just over 50 percent) and several of the processes were not regarded as having industrial potential. Based on an economic evaluation, the authors concluded that hydroseparation offered the most cost effective approach. (LTN)

HYDROGENATION

REFER ALSO TO CITATION(S) 9624, 9626, 9631, 9632, 9634

9541 (BNL—50677) **Flash hydropyrolysis of coal. Quarterly report No. 1, January 1—March 31, 1977.** (Brookhaven National Lab., Upton, N.Y. (USA)). Apr 1977. Contract EY-76-C-02-0016. 27p. Dep. NTIS, PC A03/MF A01.

The 1 lb/hr Flash Hydropyrolysis experimental equipment has been completed and is in operation. The unit was originally designed for the maximum operating conditions of 4000 psi and 800°C. To date it has been successfully operated at up to 3000 psi and 815°C with coal feed rates in excess of 2 lbs/hr. Product analysis is accomplished with the use of an on-line process gas chromatograph designed to measure CO, CO_2, H_2O, CH_4, C_2H_4, C_2H_6, C_6H_6, C_7H_8, C_8H_{10} and all hydrocarbons greater than or equal to C_9, every 6 minutes. Samples of the chromatograph can be taken from any of 6 sample taps including three located at 2 foot intervals along the 8 foot reactor. Carbon conversions in excess of 40 percent to gaseous products and 20 percent to liquid products have been observed. Preliminary process design and economic evaluations show the process to be both technically and economically feasible for commercial application.

9542 (FE—2334-4) **Phase equilibria in coal hydrogenation systems. Annual report, April 1976—March 1977.** Kobayaski, R. (Rice Univ., Houston, Tex. (USA). Dept. of Electrical Engineering). 1977. Contract EX-76-S-01-2334. 39p. Dep. NTIS, PC A03/MF A01.

Apparatus is being assembled and calibrated to measure thermodynamic properties of various organic compounds of interest in coal conversion as follows: Dew points, hydrogen solubility, vapor liquid equilibria, K values, etc. The measurements will be made on very pure zone refined compounds, which are needed because of the extreme sensitivity of physicochemical properties to composition, particularly when structural dissimilarities are involved. (LTN)

9543 **Upgrading of solid fuels.** Cole, E.L.; Hess, H.V.; Wong, J. Jr. (to Texaco Inc.). US Patent 4,047,898. 13 Sep 1977. Filed date 28 Oct 1976. 6p.

Low rank fuels are beneficiated by treatment with water at elevated temperature under superatmospheric pressure in the presence of hydrogen.

GASIFICATION

REFER ALSO TO CITATION(S) 9537, 9639, 9643, 9647, 10063, 10289

9544 (ANL-FE—49622-6) **Instrumentation and process control for fossil demonstration plants. Quarterly technical progress report, January—March 1977.** LeSage, L.G.; O'Fallon, N.M. (Argonne National Lab., Ill. (USA)). Sep 1977. Contract W-31-109-ENG-38. 66p. Dep. NTIS, PC A04/MF A01.

Progress during the quarter of January through March 1977 on ANL 189a 49622R2, Instrumentation and Process Control for Fossil Demonstration Plants (FDP) is reported. Work has been performed on updating the study of the state-of-the-art of instrumentation for Fossil Demonstration Plants (FDP), on development of mass-flow and other on-line instruments for FDP, process control analysis for FDP, and organization of a symposium on instrumentation and control for FDP. Progress in these areas is described.

9545 (ANL-FE—49622-11) **Instrumentation and process control for fossil demonstration plants. Monthly technical progress report, August 1977.** LeSage, L.G.; O'Fallon, N.M. (Argonne National Lab., Ill. (USA)). Sep 1977. Contract W-31-109-ENG-38. 35p. Dep. NTIS, PC A03/MF A01.

Instrumentation and Process Control for Fossil Demonstration Plants (FDP) is reported. Work has been performed on updating the study of the state-of-the-art of instrumentation for FDP, development of mass-flow and other on-line instruments for FDP, process control analysis for FDP, and organization of a symposium on instrumentation and control for FDP. A Solids/Gas Flow Test Facility (S/GFTF) under construction for instrument development, testing, evaluation, and calibration is described. The development work for several mass-flow and other on-line instruments is described: acoustic flowmeter, capacitive density flowmeter, neutron activation flowmeter and composition analysis system, gamma ray correlation flowmeter, optical flowmeter, and capacitive liquid interface level meter.

9546 (COO—0003-8) **Prototype pilot plant operation: Synthane process. Contractor quarterly operation report No. 11, April 1—June 30, 1977.** (Lummus Co., New York (USA)). Oct 1977. Contract EY-76-C-02-0003. 15p. Dep. NTIS, PC A02/MF A01.

Runs 1-DB-G to J were conducted from March 31 to April 6. Gas was produced for 76 hours. Feed rates and bed heights were varied at operating temperatures of 1500°F in an attempt to achieve

over 70% carbon conversion. The Plant was finally shut down on April 6 after a clinker formed in the gasifier. Carbon conversions up to 70% were achieved during the later stages of the run. The Plant was operated April 15 to 16 and again April 27 to 28. During both of these runs, emphasis was placed on attempting to make the internal cyclone operate. Run 1-DB-K lasted only 17 hours and Run 1-DB-L, only 15 hours. Both of these runs were terminated due to the formation of clinkers. Considerable improvement was noted in the solids carryover into gas scrubbing. The fines return to the bed resulted in much lower densities and poor bed level control was experienced. The gasifier was operated for a period of 8 days in May at varying conditions, in an attempt to achieve better operability with low bed densities. The gasifier was shut down after a crack developed in Incoloy 800 Nozzle No. 50 before the test program could be fully completed. The nozzle failed as a result of stress corrosion cracking. These findings necessitated the removal of all 22 similar Incoloy 800 nozzles. All nozzles are being replaced with carbon steel flanges that are monel overlaid.

9547 (COO—0003-10) **Prototype Pilot Plant Operation, Synthane Process. Contractor monthly activity report No. 36, August 1—August 31, 1977.** (Lummus Co., Bloomfield, N.J. (USA)). Sep 1977. Contract EY-76-C-02-0003. 14p. Dep. NTIS, PC A02/MF A01.

Progress achieved during August 1977 at the Synthane Pilot Plant located in Bruceton, Pennsylvania, is reported. The plant operated from August 5 to August 16 during which time 465 tons of Rosebud coal were gasified. During this period, oxygen and coal were fed for 190 hours, 98 hours of which were without interruption. The run produced ten steady state periods. Bed temperatures and feed rates were varied to study the effect of these variables on conversions. Carbon conversions of 75 percent to 78 percent were achieved for extended periods of operation at feed rates of 2 to 3 tons per hour. The successful completion of this run finishes studies of Western subbituminous coal. The Plant is presently preparing for the gasification of Illinois No. 6 coal.

9548 (ERHQ—0015) **Low-Btu coal gasification.** (Energy Research and Development Administration, Washington, D.C. (USA)). Aug 1977. 11p. Dep. NTIS, PC A02/MF A01.

Because of the energy shortage, ERDA's Division of Coal Conversion and Utilization (CCU) has directed attention to coal gasification. One of the areas of interest is low-Btu gasification. This type of gas can be made efficiently for use near the point of production and at lower cost. In 1976 CCU invited industrial, commercial, and institutional interests to propose demonstration coal gasification projects that ERDA would cost-share up to 50 percent of the total cost. The primary goal of that action was to evaluate technically and economically the integration of low-Btu coal gasification technology in various operational environments. ERDA specified that the projects be limited to 8 t/hr capacity and only state-of-the-art technologies be used. Projects were selected on the basis of overall technical feasibility, financial contribution by the participants, qualifications of the offeror and partners, ability to finance, total cost of the projects, application, type of gasifier, etc. Each proposal was reviewed on its own merit; they were not compared against each other. Six projects were selected, at least one in each category. The six include a university, a county's planned community, three industrial firms, and a development corporation's industrial park. The projects include the use of anthracite coal as well as low- and high-sulfur bituminous coals. Also included were one- and two-stage gasifiers, oil and tar removal and reuse, and secondary systems for sulfur removal from the product gas.

9549 (FE—1513-62) **Agglomerating Burner Gasification Process. Design, installation, and operation of a 25-ton-a day Process Development Unit. Quarterly report, April—June 1977.** Adams, R.R.; Corder, W.C. (Battelle Columbus Labs., Ohio (USA)). Aug 1977. Contract EX-76-C-01-1513. 28p. Dep. NTIS, PC A03/MF A01.

Attempts to achieve gasification have been hampered by mechanical problems, most significantly by refractory spalling at the bottoms of the solids circulation loops and by spalling of the refractory from the burner lining. In an effort to reduce loop erosion, the bottom sections have been modified to change the flow pattern and to permit all of the transport gas to be introduced parallel with the direction of flow. During the quarter, extended operation of the burner alone resulted in an ash capture efficiency of over 90 percent. Heat and material balances for the commercial concept flowsheet have been completed and cost estimates for the commercial concept plant are nearly finished. Fabrication of the static erosion test rig is almost complete, and six alloys have been selected for initial evaluation. Detroit Diesel Allison has been selected as the most likely vendor for an experimental turbine.

9550 (FE—1521-21) **Design report. Volume 2. Section 100: gasification. Development work for an advanced coal gasification system for electric power generation from coal directed toward a commercial gasification generating plant, Phase II.** (Foster Wheeler Corp., Livingston, N.J. (USA)). Oct 1977. Contract EX-76-C-01-1521. 276p. Dep. NTIS, PC A13/MF A01.

The function of Section 100, Gasification, is to produce raw, low-Btu, cooled, high-pressure gas from coal in a two-stage, slagging, entrained-flow gasifier with char recycled to extinction. Section 100 is made up of the following key areas: Coal Handling; Coal Pulverizing and Drying; High-Pressure Solids Feeding (Petrocarb); Coal Gasification; Slag Handling; Char Separation, Char Cooling, and Recycle Gas System; Gas Cooling and Superheated Steam Production; and a Gasifier Start-Up System. The coal handling system unloads raw coal from rail cars and crushes and transports it to coal storage hoppers. The coal pulverizing and drying system pulverizes the crushed coal and dries the coal to achieve a zero surface moisture. The high-pressure solids feeding system provides continuous, high-pressure, accurately controlled solid flows of pulverized coal, limestone fluxing agent, and recycled char. The gasification area consists of a two-stage, entrained-flow, high-pressure, slagging, "Bi-Gas" coal gasifier, which receives dry pulverized coal, steam, and air and produces high-temperature, high-pressure, sulfur-containing, low-Btu gas and hot molten slag. The slag handling system receives the hot, molten slag from the gasifier and cools and frits it. The char separation, char cooling, and recycle gas systems separate the char from the gas, cool it with recycle gas to a temperature mechanically acceptable to the Petrocarb solids feeding system, and recycle it to this system. The gas cooling system cools the raw gas before it goes to the gas purification sections and produces superheated, high-pressure steam. The gasifier start-up system quenches the hot gasifier effluent gas and char produced during start-up of the gasifier.

9551 (FE—1545-36) **Automated data acquisition and data reduction for low-Btu gasifiction of coal for electric power generation. Final report, February 1975—August 1976.** Burr, D.H. Jr. (Combustion Engineering, Inc., Windsor, Conn. (USA)). Sep 1977. Contract EX-76-C-01-1545. 191p. Dep. NTIS, PC A09/MF A01.

Candidate methods of logging and reducing test data for the C-E Coal Gasification Process Development Unit (PDU) were evaluated to select the method and equipment best suited to operational and test needs. An Automated Data Acquisition and Reduction System (ADARS), based on a minicomputer approach, was chosen over alternative methods. In addition a fill-in-the-form type application software package was selected to reduce the overall project cost and to expedite the next phase of this contract. Comparison charts, vendor meetings, inside and outside company references, and field trip evaluations were used in making the final selection of equipment.

9552 (FE—1734-33) **Lignite gasification process development. Monthly technical progress report, August 1977.** (Conoco Coal Development Co., Library, Pa. (USA). Research Div.). 22 Sep 1977. Contract EX-76-C-01-1734. 13p. Dep. NTIS, PC A02/MF A01.

Work has been completed on Phase I (Feasibility Study); Phase II (Bench-scale Research); and Phase III (Pilot Plant Engineering). Work on Phase IV (Pilot Plant Construction and Operation) is continuing. During Run 46C the inlet steam partial pressure to the gasifier was increased from the normal 11.6 atm to 12.5 atm. This seemingly small change produced the hoped-for responses. Both the acceptor activity and particle density increased, thereby showing that some liquid had formed in the system: $CaO\text{-}Ca(OH)_2\text{-}CaCO_3$. Boot operation was stable, showing that the extent of liquid formation was not enough to cause agglomeration of the acceptor. After the balance period, the steam partial pressure was increased but a control valve malfunction caused a shutdown. The new 2-in. single tube methanation reactor was operated for the first time. Results will give valuable design data on the effect of diameter for packed tube reactors.

9553 (FE—1759-1) **Oil-Gas Plant Design Project capital cost validation.** (Army Engineer Div., Huntsville, Ala. (USA)). 30 Mar 1977. Contract EX-76-C-01-1759. 24p. Dep. NTIS, PC A02/MF A01.

The U.S. Army Engineer Division, Huntsville (USAEDH) has reviewed, validated, and updated a capital cost estimate of the "Commercial Complex Conceptual Design/Economic Analysis, Oil-Gas Plant." R and D Report No. 114. This facility was designed to have a feed rate of 36,000 tons per day of clean coal and produce about 56,000 barrels per day of fuel oil, 10,000 barrels per day of naptha, 10,000 barrels per day of liquefied petroleum gas, 165 million standard cubic feet a day of synthetic natural gas, 1,300 tons per day of sulfur, and 90 tons per day of anhydrous ammonia. Results of the USAEDH estimate showed a fixed capital cost of $1,183 million which is less than the Parsons estimate of 1,228 million (both estimates based on March 1976 dollars). The overall confidence factor was determined to be plus or minus 4 percent. Escalation of the USAEDH estimate to May 1976 resulted in a fixed capital cost of $1,217 million for the facility.

9554 (FE—1767-9) **Mixing and gasification of coal in entrained flow systems. Final report, November 29, 1974—April 30, 1977.** Smoot, L.D.; Hanks, R.W. (Brigham Young Univ., Provo, Utah

(USA). Dept. of Chemical Engineering). 15 May 1977. Contract EX-76-C-01-1767. 108p. Dep. NTIS, PC A06/MF A01.

This final report presents work accomplished in an investigation of mixing and gasification of coal in entrained flow systems. The general objective is to develop an understanding of the physical and chemical rate processes that occur during gasification. A test program of approximately 54 experiments was designed with test variables to include pressure, coal type and size, injection angles, preheat temperature and solids loading. Values of test variables were based upon typical entrained gasifier operating conditions. Design, construction and installation of an entrained-flow, high-pressure laboratory gasifier was nearly completed. One hundred and three cold-flow, jet mixing tests were conducted using an existing test facility. Test conditions simulated coal gasifier conditions. Effects of injection angle, mixing chamber size, flow velocity and temperature, and coal size and loading were measured. Injection angle, mixing chamber size, and flow velocity had major effects on rates of gas and particle mixing. A unique technique for independently controlling gas and particle mixing rates was suggested. A computer code was developed for a one-dimensional model of entrained coal gasification processes. Programming was completed and debugging was nearly completed.

9555 (FE—1775-12) **Preliminary design services coal conversion demonstration plants. Research and Development report No. 114. Quarterly report, April—June 1977.** (Parsons (Ralph M.) Co., Pasadena, Calif. (USA)). Aug 1977. Contract EX-76-C-01-1775. 24p. Dep. NTIS, PC A02/MF A01.

Progress in the design of several coal conversion facilities is reported. Supporting efforts include planning, equipment development, construction materials development and environmental factors. Prestressed concrete pressure vessels have been designed, and construction procedures are being developed. Stress analyses of these designs have been carried out using the finite element method. (LTN)

9556 (FE—1784-27) **Program to discover materials suitable for service under hostile conditions obtaining in equipment for the gasification of coal and other solid fuels. Quarterly progress report, January 1—March 31, 1977.** Schaefer, A.O. (ed.). (Metal Properties Council, Inc., New York (USA)). 1 Jul 1977. Contract EX-76-C-01-1784. 122p. Dep. NTIS, PC A06/MF A01.

Progress is reported on a program under the direction of The Metal Properties Council, Inc., designed to screen materials for use in such plants with respect to the various unique corrosive environments obtaining therein; and, finally to provide useful corrosion data as well as reliable information on other properties needed for the design, construction, and operation of such plants. Specific results are summarized.

9557 (FE—2006-5) **Applied research and evaluation of process concepts for liquefaction and gasification of western coals. Quarterly progress report, July—September 1976.** Wiser, W.H. (Utah Univ., Salt Lake City (USA). Dept. of Mining, Metallurgical and Fuels Engineering). Mar 1977. Contract EX-76-C-01-2006. 123p. Dep. NTIS, PC A07/MF A01.

Research in support of coal gasification and coal liquefaction is reported. The work deals with fundamental and experimental catalyst studies, hydrogenation and hydrogenolysis reactions on coal or coal liquids (with or without catalysts), upgrading and refining coal liquids (including fractionation and structural chemical analysis of the fractions), light hydrocarbon synthesis (with catalysts), special studies using metal halide catalysts, pyrolysis of coal and coal liquids, and other miscellaneous projects. In several areas the behavior of pure model compounds in these reactions has been studied as a means of understanding the behavior of more complex materials. (LTN)

9558 (FE—2203-16) **Investigation of converting the product of coal gasification to methane by the action of microorganisms: phase I. Fourth quarterly report, September 1—December 1, 1976. Dynatech report No. 1559.** Augenstein, D.C.; Wise, D.L. (Dynatech R/D Co., Cambridge, Mass. (USA)). 15 Dec 1977. Contract EX-76-C-01-2203. 54p. Dep. NTIS, PC A04/MF A01.

In the program to develop a process for bioconversion of coal gasifier product gases to methane, the principal experimental objectives were to increase productivity through thermophilic operation in conjunction with recycle, to demonstrate high pressure, high-rate, thermophilic operation with recycle, and to demonstrate the practical biological shift conversion of carbon monoxide. Hydrogen sulfide tolerance experiments were also carried out under thermophilic conditions. Thermophilic operation with recycle has resulted in the highest productivities obtained to date, exceeding 200 VVD. In addition, high productivities in the order of 100 VVD have been delivered in thermophilic pressure fermentations to 120 psig with recycle. Encouragingly rapid rates of CO conversion have been obtained in initial trials utilizing a new organism and medium; an initial shift rate and hydrogen productivity of 15 VVD has been attained. In trials to establish the sensitivity of the thermophilic culture to hydrogen sulfide, no inhibition of culture productivity was seen at hydrogen sulfide concentrations as high as 10 percent in the test gas mix.

9559 (FE—2229-5) **Surface structure and mechanisms of gasification catalyst deactivation. Quarterly report, January—April 1977.** Reucroft, P.J.; Bradley, E.B.; De Angelis, R.J.; Sargent, G.A. (Kentucky Univ., Lexington (USA)). Aug 1977. Contract EX-76-C-01-2229. 72p. Dep. NTIS, PC A04/MF A01.

Additional ESCA standard samples (NiS, $NI(OH)_2$) have been examined. NiS was found to have very little surface charging and small chemical shifts (compared to the Ni metal). A quantitative analysis of the L140 catalysts revealed that particle sizes do not change greatly with increasing metal loading; binding energies and peak shapes correspond to a nickel aluminate complex. Two used catalysts were studied in order to assess the effects of exposure to synthesis gas and presulfiding. The presulfiding treatment effectively saturated the catalyst with sulfur. Thermal gravimetric analysis has been used to study the effects of temperature and hydrogen flow rates on the reduction kinetics of NiO dispersed on silica and alumina supports. Raman spectra of the SiO_2 and Al_2O_3 support materials show very weak bands characteristic of amorphous solids. Photodecomposition of $NiCO_3$ and $NiSiO_3$ samples limited incident laser power but their Raman band intensities are also small. Fluorescence did not obscure the Raman bands of these powdered samples; it has been shown to depend on sample preparation and handling. The Raman spectrum of the sulphided alumina-support catalyst shows characteristic sulfate and sulphite bands. Auger electron spectroscopy was employed for the study of the elemental depth distribution of the Ni catalysts. The result has shown that a contaminated layer of depth 400A was present on the surface. NiO particles were more susceptible to the contamination than Al_2O_3 particles. The Auger electron escape depth for SiO_2 supported catalysts is about the same as for Al_2O_3 supported catalysts.

9560 (FE—2231-4) **Heat transfer in a fluidized countercurrent bed. Annual report, May 1, 1976—April 30, 1977.** Jackson, R. (Rice Univ., Houston, Tex. (USA)). May 1977. Contract EX-76-C-01-2231. 32p. Dep. NTIS, PC A03/MF A01.

During this initial year of the contract, work has been devoted to preliminary tests whose results are needed to design an apparatus for investigation of the downflow of larger and/or denser particles through a fluidized bed of smaller and/or less dense particles. Rough measurements of limiting flow rates of the descending particles have determined a practical scale for the apparatus and its associated hoppers, feed systems, and fluidizing air supply system. Extensive trials have been carried out to establish a satisfactory design for a feed system to supply descending particles to the upper surface of the fluidized bed. The problems of maintaining a constant total flow and a reasonably uniform cross-sectional flow distribution, for irregularly shaped and non free-flowing particles, have been solved. The overall design of the apparatus is now complete, and detailed drawings for fabrication of its components are being prepared.

9561 (FE—2240-71) **Quarterly technical progress report, April—June 1977.** Detman, R. (Braun (C.F.) and Co., Alhambra, Calif. (USA)). Oct 1977. Contract EX-76-C-01-2240. 20p. Dep. NTIS, PC A02/MF A01.

All of the pilot plants in the joint ERDA-A.G.A. Coal Gasification program conducted operations during the quarter and were monitored by Braun process investigators. The HYGAS Steam-Oxygen pilot plant made several runs on Illinois Peabody Number 10 bituminous coal. Sustained operation at the desired temperatures and coal conversions was not achieved, but was closely approached for a four-hour period of operation. The CO_2 Acceptor plant made runs on Wyodak subbituminous coal and plans runs at higher pressure, and will test the use of reconstituted acceptor before completing the planned program for the plant. The BI-GAS pilot plant operated for short periods, encountering problems with slag removal. Changes in operation have apparently solved this problem. The Synthane plant has changed to feed injection into the fluidized bed and eliminated overhead plugging problems. Reduced bed densities have caused some problems with char removal. Work continued in eleven process study areas. Four study reports were submitted to ERDA-A.G.A. for approval. A report on mechanical development recommendations was published, and a follow-up report on investigation of these programs was submitted for approval. Work was started on two instrument development programs. Reviews of eastern coal factored estimate designs resulted in decisions by the Operating Committee to modify the guidelines for the eastern cases. Work commenced changing plant designs in accordance with the revised guidelines.

9562 (FE—2275-3) **Systems studies of coal conversion processes using a reference simulator. Quarterly report, December 12, 1976—March 31, 1977.** Reklaitis, G.V.; Woods, J.M.; Kayihan, F.; Sood, M. (Purdue Univ., Lafayette, Ind. (USA)). Apr 1977. Contract EX-76-C-01-2275. 54p. Dep. NTIS, PC A04/MF A01.

Progress is reported in the development of a modular computer simulation/design package for coal conversion systems based on bench-scale and large pilot plant data. The initial work is based on COGAS and COED process results. The package should be useful for evaluating various flowsheet alternatives. (LTN)

9563 (FE—2299-16) **Sulfidation-resistant alloy for coal gasification service. Monthly report, September 1—30, 1977.** Perkins, R.A.; Bhat, M.S. (Lockheed Missiles and Space Co., Palo Alto, Calif. (USA). Lockheed Palo Alto Research Lab.; California Univ., Berkeley (USA)). 8 Oct 1977. Contract EX-76-C-01-2299. 6p. Dep. NTIS, PC A02/MF A01.

Corrosion tests on complex alloys expound to the ERDA/MPC gas atmosphere with added 1 percent H_2S at 1800°F and 500 psi are reported. The objective is to develop sulfidation resistant alloys for coal gasification service. (LTN)

9564 (FE—2338-3) **Development of a modular software system for the dynamic simulation of coal conversion plants. Quarterly report, January—March 1977.** Schiesser, W.E.; Stein, F.P. (Lehigh Univ., Bethlehem, Pa. (USA)). Apr 1977. Contract EX-76-C-01-2338. 40p. Dep. NTIS, PC A03/MF A01.

The basic Differential Systems Simulator, Version 2 (DSS/2) has been completed and released along with complete sets of manuals and test problems. This system contains fourteen Runge-Kutta algorithms for ordinary differential equations, five central-differencing subroutines for partial differential equations, and a series of utility routines for plotting and function generation. Stand-alone testing of the state-of-the-art implicit Gear and Carver integrators has been accomplished by the preparation of interface programs which restructure the data tables from the form which is convenient for the modeler and acceptable to DSS/2 to the form required by the particular integration algorithm being tested. The steady-state methanator for the methanation section of the RM Process has been modeled as a catalytic, adiabatic, plug-flow reactor which considers simultaneous water-gas shift and methanation reactions. The coding has been thoroughly tested, and documentation has been presented. The unsteady-state methanator has been coded under the same model conditions as the steady-state reactor. Upsets introduced into the model have shown some transients, but the results are not completely satisfactory. Efforts to solve the problems by mating the model and the temporal integration techniques are proceeding. Progress on the detailed model of the heat exchanger has followed exactly the path of the unsteady-state methanator. Work has begun on the fluidized-bed char gasifier of the COGAS gasification section in regard to particle size distribution within the reactor and its associated streams.

9565 (FE—2342-12) **Molten Salt Coal Gasification Process Development Unit. Quarterly technical progress report No. 3, October—December 1976.** (Atomics International Div., Canoga Park, Calif. (USA)). 24 Jan 1977. Contract EX-76-C-01-2342. 28p. Dep. NTIS, PC A03/MF A01.

The Molten Salt Coal Gasification Process Development Unit (PDU) project was initiated in March 1976 and includes the design, construction, and operation of a PDU which will convert one ton of coal per hour into a low-Btu gas. The decision was made to prepare the detailed design of the PDU facility "in-house," and a special task force was established to accomplish the work. By the end of December, specifications for all major long-lead procurement items had been prepared, the gasifier design layout had been completed, a soils and foundation investigation had been made at the site, and work had been started on the specifications and drawings required for plant construction. In order to improve the program schedule, a plan for phased construction was developed, and as a result, the engineering effort during the report period emphasized the civil and structural work scheduled for early release.

9566 (FE—2355-22) **Coal gasification valves. Phase I. Failure modes and effects analysis: 8-inch valves, types I, II, and IV (CCC P/N 75895).** Roberts, R.A. (Consolidated Controls Corp., El Segundo, Calif. (USA)). Sep 1977. Contract EX-76-C-01-2355. 10p. Dep. NTIS, PC A02/MF A01.

This document presents the Failure Modes and Effects Analysis (FMEA) of the Types I, II, and IV Valves (CCC drawing number 75895) for the Lock-Hopper Valve Development Program. Data includes part and item numbers from the 75895 drawing; identification of all items with probable or critical failure modes; the function performed by each item; all credible or critical failure modes; the probable cause(s) of each failure mode; the direct effect on valve function; the potential hazards to personnel; the method of detection of a specific failure mode; preventive or corrective action; and alternate means of back-up.

9567 (FE—2414-2) **Remote electromagnetic sensing of underground coal burns. Quarterly technical progress report, September—November 1975.** Quincy, E.A. (Wyoming Univ., Laramie (USA). Dept. of Electrical Engineering). Dec 1976. Contract EX-76-S-01-2414. 26p. Dep. NTIS, PC A03/MF A01.

The main objective of this project is to develop and field test an inducation system and estimator algorithm for remote determination of the shape and size of underground coal burn voids. The newly configured induction system was field tested on several traverses at Hanna. A computer program was written and tested for generation of induction responses of buried conducting boxes. During the second quarter field tests were continued. Field data was processed on the new Fourier Analyzer System and 3-dimensional response maps were plotted via the central computing system in both time and frequency domains. The response exhibited a 100-to-1 anomaly at 25 kHz as the system was moved across this site. Two Bayes estimator algorithms were derived for the radius of an infinitely long cylinder. A Monte Carlo simulation demonstrated that the numerical algorithm performed nearly identical to the analytic algorithm at various signal-to-noise ratios. Optional conducting wells were added to the computer program for responses of buried conducting boxes. However, this modeling does not produce significant response anomalies commensurate with those obtained by field measurements. Consequently the air/earth interface effect will be included next.

9568 (FE—2414-3) **Remote electromagnetic sensing of underground coal burns. Quarterly technical progress report, December 1976—February 1977 and 9 month summary.** Quincy, E.A. (Wyoming Univ., Laramie (USA). Dept. of Electrical Engineering). Mar 1977. Contract EX-76-S-01-2414. 79p. Dep. NTIS, PC A05/MF A01.

The main objective of this project is to develop and field test an induction system and estimator algorithm for remote determination (at the surface) of the location, shape and size of underground coal burn voids. Field measurements were conducted with a wide-band loop-loop induction system at the Hanna Underground Coal Gasification Site of the LERC during July, August and October of 1976. Field data were processed on the new Fourier Analyzer System and 3-dimensional response maps were plotted via the central computing system in both time and frequency domains. Strong anomalies at 5 kHz were observed on traverses over both burns at Hanna II. Computer programs for generation of induction responses of 3 different buried conducting bodies have been written and tested. The effects of conducting wells and the air-earth interface were explored. A Bayes statistical estimation procedure was developed to interpret induction responses for shape and size information. An analytic and a numerical minimum mean-square-error algorithm were developed for the estimation of the radius of a cylindrical conductor. Performance of the general numerical algorithm was shown to be nearly identical to that of the analytic algorithm.

9569 (FE—2468-14) **ESCOE engineering program. Quarterly report, June 1, 1977—August 31, 1977.** Hill, R.F. (Engineering Societies Commission on Energy, Inc., Washington, D.C. (USA)). 1977. Contract EF-77-C-01-2468. 10p. Dep. NTIS, PC A02/MF A01.

Planning and recruiting efforts for the Engineering Societies Commission on Energy, Inc. (ESCOE)/ERDA engineering program are reported. This is an undertaking by five founder engineering societies and involves the establishment of administrative and professional capabilities in facilities located in Washington, D.C. (LTN)

9570 (FE—2489-12) **Development of combustion data to utilize low-Btu gases as industrial process fuels. Project 8985 quarterly status report, April 1—June 30, 1977.** Waibel, R.T. (Institute of Gas Technology, Chicago, Ill. (USA)). Oct 1977. Contract EX-76-C-01-2044. 21p. Dep. NTIS, PC A02/MF A01.

The reformer and the furnace system were tested, and final preparations were made for beginning the experimental runs. A project review meeting was held to finalize the test procedure. A Bloom baffle burner of 7.2×10^6 Btu/hr capacity was selected as the first burner for testing and installed on the furnace, and water cooling tubes were inserted along the furnace sidewall to simulate the preheat section of a five-zone slab reheat furnace. Natural gas baseline data were collected for thermal efficiency, heat absorption profile, flame shape, isothermal profiles, flow direction, thermal radiation, post flame emissivity, and noise level. Flame stability tests were made with Koppers-Totzek oxygen, Wellman-Galusha air, and Winkler air fuel gases. No instability was encountered when Koppers-Totzek oxygen or Wellman-Galusha air fuel gas was fired at 5.25×10^6 Btu/hr, equal to the natural gas firing rate. Winkler air fuel gas developed flame instability at an enthalpy input of about 60 percent of the natural gas input.

9571 (FE—2517-5) **Portfolio selections for fossil demonstration plant programs. Report No. 1-703.** English, J.M.; Smith, J.L.; Grant-Smith, S.G. (Econergy, Inc., Los Angeles, Calif. (USA)). Jan 1977. Contract EX-76-C-01-2517. 232p. Dep. NTIS, PC A11/MF A01.

The Econergy portfolio model has been developed for evaluating coal conversion processes as candidates for demonstration plant-funding. The group of processes which is selected will form what is, in effect, an investment portfolio for ERDA. The evaluation procedure utilizes information on process economics and process

risks. Both kinds of information are combined for each process so that a comprehensive comparison among the individual processes can be made. In addition, information regarding process similarities and dissimilarities is used to provide a comparison of various combinations of the processes. The portfolio model calculations result in two numbers, benefit and risk, which are used to describe uniquely a portfolio of coal conversion processes. These numbers form a point on a two-dimensional plot termed an unnormalized benefit/risk map. By normalizing these data on a per dollar invested basis, the results can be plotted on a normalized benefit/risk map. The benefit/risk information presented in this manner can be used as a significant decisionmaking tool.

9572 (FE—2518-3) **Hydrogasifier development for the Hydrane process. Monthly progress report, May 1977.** Gray, J.A. (Cities Service Research and Development Co., Cranbury, N.J. (USA)). Jun 1977. Contract EF-77-C-01-2518. 22p. Dep. NTIS, PC A02/MF A01.

The objectives of this program are to develop a single-stage, short-residence-time reactor design for the Hydrane coal gasification process, and to generate the process data necessary to design a pilot plant. The basic concept of the Hydrane process is to produce most of the product methane (> 90%) by the direct reaction of coal with hydrogen. This method has been shown in several studies to be more thermodynamically efficient and possibly less costly than producing a large share of the methane by steam/oxygen gasification followed by catalytic methanation of carbon monoxide and hydrogen.

9573 (FE—2518-5) **Hydrogasifier development for the Hydrane process. Monthly progress report, June 1977.** Gray, J.A.; Greene, M.I. (Cities Service Research and Development Co., Cranbury, N.J. (USA)). Jul 1977. Contract EF-77-C-01-2518. 34p. Dep. NTIS, PC A03/MF A01.

The Cities Service bench-scale unit coal feed system was modified to handle plant grind coal (70%—200 mesh), a deviation from earlier test experience. However, Montana Rosebud coal from a supplier did not meet the desired specifications of moisture and particle size so that tedious drying and elutriation of fines in small batches were required to get the test program underway. The gravity feed system would not function with the original coal because 20% was too fine (well below 325 mesh in size) despite the modifications. Five tests were completed in June. At 1500°F and 500 psig, the carbon conversions were 39.0 and 31.9% at residence times of 1521 and 416 msec, respectively. Product yield data are not yet available. The designs of the 1/4 ton/hr reactor, preheater, preburner, injector, and quench section were completed including all of the detailed shop fabrication drawings. Bid packages were sent out for some of these items, and the remaining items are being fabricated in-house. All components are anticipated to be on the test site ready for assembly during the first week of August. Modification of the 1/4 ton/hr test facility is proceeding on schedule. Programming of the homogeneous gas phase reaction portion of the Rocketdyne reactor model is in progress and is expected to be operational by the end of July.

9574 (FE—2518-7) **Hydrogasifier development for the Hydrane process. Monthly progress report, August 1977.** Combs, L.P.; Greene, M.I. (Cities Service Research and Development Co., Cranbury, N.J. (USA)). Sep 1977. Contract EF-77-C-01-2518. 19p. Dep. NTIS, PC A02/MF A01.

Cities Service completed nine tests in Task 2 during August using two helical entrained flow reactors. A total of 23 tests have been run to date at hydrogen pressures of 500 to 1500 psig, temperatures of 1500 to 1728°F, and residence times of 295 to 2956 msec. Carbon conversions, ranging between approximately 19 and 45%, and product yields with Montana Rosebud subbituminous coal continued to agree, within the data scatter, with previous Cities Service data with lignite. Buildup and activation of the 1/4-ton/hr test facility were completed and two Task 3A facility checkout tests were accomplished. The entrained flow reactor model being developed by Rocketdyne in Task 4 is nearing completion. Work was continued during August toward completing the computer programming, with emphasis on the coal particle dynamics portion of the model.

9575 (FE—2565-4) **Analysis of coal hydrogasification processes. Monthly technical progress report, August 1—31, 1977.** (Bechtel Corp., San Francisco, Calif. (USA)). Sep 1977. Contract EF-77-A-01-2565. 35p. Dep. NTIS, PC A03/MF A01.

This program is being performed in four sequential tasks: Task I—Data Collection; Task II—Data Analysis; Task III—Process Modeling; and Task IV—Identification of Additional Data and Recommended Experimental Programs. During August, substantial progress was made on Task III. Data from nine recent Cities Service hydrogasification tests using Montana Rosebud subbituminous coal were entered into a computerized data base, which contains data from 25 earlier Cities Service partial liquefaction tests using a lignite coal. Semiempirical correlations for predicting carbon conversion efficiency, carbon selectivity to gas, and carbon selectivity to methane and ethane were fitted to the data. Neither coal type nor the reactors used (free-fall versus entrained-flow) appeared to have any significant effect on carbon conversion or carbon selectivity. An analysis of process design, control methods, and other matters pertaining to engineering judgment that affect PDU and commercial-scale plant operability and/or feasibility is continuing. Preliminary variable levels were chosen for the design of a conceptual full-scale Rocketdyne reactor, based on 50% overall carbon conversion and 100% carbon selectivity to gas.

9576 (FE/WAPO/0020—1) **Effect of plant size on the cost of producing industrial gas in small fixed bed gasifiers.** (Bechtel Corp., San Francisco, Calif. (USA)). Jun 1976. Contract EX-76-X-01-0020. 34p. Dep. NTIS, PC A03/MF A01.

The purpose of this study is to investigate the effect of plant size on the unit cost of industrial gas from small fixed-bed producers in a capacity range in which all of the plants considered are small. Industrial gas is medium-Btu (300 Btu/SCF) fuel gas that is produced by oxygen-blown gasification of coal followed by steps for gas cleanup. The resulting gas, rich in hydrogen and carbon monoxide, would be distributed in its own pipeline network among a cluster of local industrial users. Bechtel has examined the cost of gas from small gasifiers in plants with capacities of approximately 2, 7 and 20 billion Btu/day. The results of the studies show that the cost of fuel gas produced in the smallest plant is greater than that produced in the largest plant by roughly 75 percent.

9577 (FE/WAPO/2526—1) **Effect of plant size on the cost of producing industrial gas.** (Bechtel Corp., San Francisco, Calif. (USA)). Mar 1976. 35p. Dep. NTIS, PC A03/MF A01.

The industrial sector could make a relatively smooth transition to the use of medium-Btu (300 Btu/SCF) fuel gas. However, the economics of using such industrial gas are not yet clear. Therefore some orientation regarding the cost trade-offs between plant size, distribution and market size is desirable. The purpose of this study is to investigate the effect of plant size on the unit cost of the gas. Industrial gas is produced by the oxygen-blown gasification of coal followed by steps for gas clean-up. The resulting gas, rich in hydrogen and carbon monoxide, would be distributed in its own pipeline network among a cluster of local industrial users. An initial step in evaluating the economics of industrial fuel gas is the determination of what order of plant scale would yield the least expensive gas product. This study examines the shift of gas cost when plant size is varied from about 10 to 50 to 200 billion Btu/day production rate. The results indicate that the overall economy of scale achieved by increasing plant size is significantly more pronounced at the lower plant sizes considered. This behavior results largely from the requirement to raise capacity by adding trains in the absence of larger equipment sizes and is most apparent in the cases of the gasification and oxygen production modules, which account for half or more of the total plant capital costs. Other plant modules are amenable to scale-up of equipment size, thus permitting economies. The cost of operating personnel turns out to display greater economy-of-scale effects than any other cost component. Compared to a plant capacity ratio of 1:5:21 for the plants considered, the annual costs of gas production for these plants are in a ratio of 1.0:4.0:15.4.

9578 (NBS-SP—468) **MFPG prevention of failures in coal conversion systems.** Shives, T.R.; Willard, W.A. (eds.). (National Bureau of Standards, Washington, D.C. (USA)). Apr 1977. 239p. (CONF-760472—). GPO $3.00.

From Prevention of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

These Proceedings consist of a group of 20 submitted papers and discussions from the 24th meeting of the Mechanical Failures Prevention Group which was held at Battelle, Columbus Laboratories in Columbus, Ohio on April 21 to 23, 1976. Prevention of failures in coal conversion systems is the central theme of the Proceedings. A series of overview lectures dealing with reliability problems in coal conversion systems, economics of failures in energy-generating systems, corrosion, and gaps in engineering data are presented. In addition, failure analysis, materials problems, and related materials research are discussed. The papers have been abstracted and indexed separately.

9579 (NBS-SP—468, pp 3-26) **Reliability problems in coal gasification and liquefaction.** Frankel, H.E. (Energy Research and Development Administration, Washington, DC); Ogren, J.R. Apr 1977.

From Prevention of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

Coal gasification and coal liquefaction are two generic techniques for converting coal to environmentally acceptable gaseous and liquid fuels and chemical feedstocks. The two techniques are distinctly different in many ways but, in many others, use numerous similar components. Significant reliability problems exist in coal conversion. The most important aspect of the problem is the absence of a domestic commercial industry in coal conversion. Reliability data from commercial operations do not exist and must be generated

from the next best source: ERDA pilot plants and demonstration projects. A description is presented of both the advantages and problems in reliability resulting from the absence of a commercial industry. Critical interfaces are described between the reliability effort and mission-oriented offices in ERDA responsible for pilot and demonstration projects. Also described is failure avoidance progress conducted, under ERDA sponsorship, at the national laboratories, government laboratories, and in private industry. Recent progress is described in development of a performance assurance approach to coal conversion plant design. Plans for the future are outlined.

9580 (NBS-SP—468, pp 41-49) **Demonstration of a reliability methodology using two coal conversion plant models.** Hoffman, J.R.; Long, W.T.; Williams, R.L. (Kaman Sciences Corp., Colorado Springs). Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

In 1975 the Office of Fossil Energy sponsored a research program to demonstrate the use of a reliability methodology for modeling process flow in coal conversion plants. The methodology was applied to the Institute of Gas Technology HYGAS and the FMC Corporation COED pilot plants. The methodology, called GO, had previously been successfully applied to a variety of complex systems involving electronic, hydraulic, and mechanical subsystems. Other applications of GO have included the human interfaces, many of which are common to several subsystems and necessary for proper system operation. A brief introduction to the GO methodology and an overview of its application to coal gasification plants are presented.

9581 (NBS-SP—468, pp 50-79) **Critical materials problems in coal conversion.** Staehle, R.W. (Ohio State Univ., Columbus). Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

The stability of engineering materials in coal conversion systems is reviewed with respect to effects of specific chemical species: carbon, sulfur, oxygen, hydrogen, chloride, and other species. These chemical species operate both at low temperatures and high temperatures to accelerate the deterioration of engineering materials. These species participate both in general degradation as well as highly localized attack such as stress corrosion cracking, dusting, intergranular attack and break away reaction phenomena. In addition to the strictly chemical influences on the metals, the deterioration of metals in the coal conversion systems is accelerated by erosion and static and cyclic stresses which lead to stress corrosion cracking, hydrogen embrittlement, and corrosion fatigue.

9582 (NBS-SP—468, pp 80-93) **AGA-ERDA-MPC program on materials for the gasification of coal.** Schaefer, A.O. (Metal Properties Council, Inc., New York). Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

An overview is presented of a large program. The roles of AGA, MPC, and ERDA and the various contributions of their respective organizations will be described. The attack on the problem and its division into phases will be explained. The scope of each phase will be clarified. The plans for Phase V will then be described at least as fully as in the latest work schedule. Plans of MPC include ultimate publication of this work in a form and by an organization which will make it possible for the book to be referenced in scientific literature.

9583 (NBS-SP—468, pp 97-106) **Failure analysis of components from coal-gasification pilot plants.** Greenberg, S.; Natesan, K. (Argonne National Lab., IL). Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

Construction materials in coal-gasification pilot plants are subjected to a variety of corrosive/erosive environments, ranging from liquids and solids at relatively low temperatures to gas and solid mixtures at high temperatures and pressures. Component failures may be directly attributed to interactions between the materials and the corrosive/erosive environment. Two corrosion failures that have been examined are discussed in detail: (1) Inconel 702 thermocouple sheath exposed to a multicomponent gas environment at 2000°F and 1200 psi, and (2) Types 304 and 316 stainless steel instrument tubing containing superheated steam-oxygen mixtures at 600°F and 1200 psi. The failures were examined in detail using optical metallography, scanning-electron microscopy, and electron-microprobe techniques as well as chemical analyses and nondestructive testing methods. The failure of the thermocouple sheath was attributed to internal oxidation of chromium and aluminum present in Inconel 702. The failure of the instrument tubing was associated with chloride stress-corrosion cracking. Details of the analyses and possible solutions to prevent such failures in the future will be presented. In addition, other ANL investigations of gasification plant components are summarized.

9584 (NBS-SP—468, pp 137-144) **Selection of materials used in coal gasification plants.** Howes, M.A.H. (IIT Research Inst., Chicago). Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

A large number of materials of construction are being evaluated for their resistance to different environments expected in various components of coal gasification pilot plants. Several alloys have been found to be promising for application in the high-temperature, high-sulfur environment. The pilot plant exposure tests are now well under way with test coupons installed in four plants and plans made to include three others. Results are now available from the aqueous program, and a statistically designed test sequence is now being commenced. The erosion/corrosion test program is in the early stages, and three reactors are under construction. When the data become available and their reliability and long-term reproducibility characterized, the information will be an invaluable aid in designing and costing commercial coal gasification plants.

9585 (NBS-SP—468, pp 145-158) **Particle erosion measurements on metals at elevated temperatures.** Ives, L.K.; Young, J.P.; Ruff, A.W. Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

Measurements of the erosive wear of metals resulting from impact by abrasive particles under reactive environmental conditions are being conducted. Specimens of several stainless steel and nickel alloys have been exposed to a gas stream containing abrasive particles. The particle flux, angle of attack, particle velocity, particle size, surface temperature and other significant variables were controlled. Different types of abrasives were used including Al_2O_3, SiO_2, SiC and pumice. Two different erosion test apparatus have been developed and used to obtain particle velocities from 10 to 90 m/s and temperatures up to 1000°C. Different gaseous atmospheres have been established during the erosion exposures. Weight loss measurements and penetration depth measurements were conducted on the specimens after exposure. Multiple alloy specimen packages were used in some experiments to obtain relative erosion data. Erosion rates were determined in the temperature range of 25 to 1000°C. Erosion depended on particle velocity over the range V^2 to V^3, increased with particle size, increased with particle hardness, and was maximum from an angle of attack around 20°. The effects of temperature and environment vary in a complicated way among the different alloys.

9586 (NBS-SP—468, pp 159-171) **High-temperature corrosion.** Natesan, K. (Argonne National Lab., IL). Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

Materials considered for application in the high-temperature gaseous environments that are present in various coal-gasification processes must possess good structural integrity at elevated temperatures and inherent resistance to the corrosive atmospheres. A thermodynamic approach has been developed to characterize the gas environment in different pilot plant coal-gasification processes. The analysis is used to examine the thermodynamic stability of iron- and nickel-base alloys in these process environments. The results show that the sulfur and oxygen potentials in all processes are in a region where chromium oxide will be thermodynamically stable. In the absence of a continuous oxide layer, sulfidation of the alloys is expected which can lead to severe corrosion rates, particularly when liquid nickel sulfides are formed. It is concluded that a protective Cr_2O_3 layer is essential for an effective application of these alloys in coal-conversion processes.

9587 (NBS-SP—468, pp 172-182) **Development of nondestructive evaluation methods for coal-conversion systems.** Ellingson, W.A.; Stanton, G.C.; Lapinski, N.P. (Argonne National Lab., IL). Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

Coal-conversion processes require the handling and containment of high pressure, high temperature, corrosive and erosive gases and liquids often containing particulate loadings. These severe environments cause materials failures that reduce successful and long-time operation of coal-conversion systems. The determination of the material and component response and development calls for proper nondestructive examination methods, equipment, and techniques. This paper briefly describes the nondestructive development efforts in high-temperature, wall-thickness measurements for in situ erosion

data, passive infrared imaging applications for thermal profiles, gamma radiographic applications for crack and erosion detection and acoustic methods for failure prediction.

9588 (NBS-SP—468, pp 183-188) **Potential materials problems in coal gasification systems.** Hall, A.M. (Battelle Columbus Labs., OH). Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

Potential problems with structural materials in those coal gasification systems designed to produce a make gas for conversion to pipeline quality gas are discussed. The following problem areas are covered: corrosion and erosion/corrosion; wear and abrasion; hydrogen effects; creep and creep-rupture; temper embrittlement of steel; thermal fatigue; component design and manufacture; material quality; and assembly of components and equipment. Both metallic and ceramic materials are discussed in terms of these potential problem areas.

9589 (NBS-SP—468, pp 195-198) **High Btu gasification pilot plant experience.** MacNab, A.J. (C.F. Braun and Co., Alhambra, CA). Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

Pilot plant component failures require careful analysis to maximize the information on materials performance. The key to any successful system of analysis would seem to be at the plant where problem recognition is needed.

9590 (NBS-SP—468, pp 199-201) **CO_2 acceptor process.** Schulz, C.A. (Conoco Coal Development Co., Library, PA). Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

The CO_2 Acceptor Process, a fluidized bed system to convert lignite or subbituminous coal to pipeline gas, is undergoing testing in a 40-ton per day, $10,000,000 pilot plant at Rapid City, South Dakota. The demonstration program is being carried out by Conoco Coal Development Company under a contract with ERDA and the American Gas Association. A schematic diagram of the CO_2 Acceptor Process is shown. There are two fluidized bed reactors, a gasifier, and a regenerator which operate at a pressure of 150 psig. Lignite or subbituminous coal is fed to the bottom of the gasifier where, after rapid hydrodevolatilization, gasification of fixed carbon with steam occurs. The gasifier temperature is in the range of 1480 to 1550°F. Heat for the gasification reactions is supplied by a circulating stream of lime-bearing material called acceptor. The acceptor, which can be either limestone or dolomite, supplies heat needed for gasification by the exothermic CO_2 acceptor reaction.

9591 (NBS-SP—468, pp 202-204) **Consol pilot plant materials problems.** Leterle, J.F. (Continental Oil Co., Ponca City, OK). Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

Recycle gas heaters suffered severe sulfidic corrosion of Incoloy 800 tubes prior to desulfurizing the gas stream with a ZnO system. In a sulfur free recycle gas stream 321SS and Incoloy 800 tubes encountered rapid pitting attack by metal dusting until 50 percent steam was introduced into the recycle gas stream. Large vertical cracks in the inner castable refractory liner of the gasifier and regenerator vessels occurred because a light weight insulation between the refractory and the vessel shell lacked strength to support the refractory layers when the system was pressurized. Erosion of the expansion joints of an inner liner of a transfer line pneumatically carrying solids and the stress corrosion cracking of the 304SS expansion bellows of the outer pipe are other problems experienced.

9592 (NBS-SP—468, pp 205-206) **Synthane coal to gas pilot plant.** Lewis, R. (Synthane Coal to Gas Pilot Plant, Pittsburgh). Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

A description is presented of the startup operations of the pilot plant and of the difficulties encountered. There were several types of failures, but no gas was produced during the first twelve months of testing.

9593 (NP—22656) **Catalytically activated gasification of coal and coke under pressure.** Mielke, R. (Technische Hochschule Aachen (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet). 16 Jul 1976. 63p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

Thesis.

The gasification behavior of coal, semicoke and coke in flow-through pressure reactors has been examined. The batch gasification with hydrogen and hydrogen steam mixtures was used. Sodium carbonate alone or in combination with zinc oxide of uranium dioxide was used as an activating additive. The results concerning coal carbonization, gasification dependence on the coal or coke temperature, activation with soda and the material balance have been given.

9594 (ORNL/EIS—94, pp 3.1-3.125) **Conversion processes.** Huffstetler, J.K.; Rickert, L.W. Apr 1977.

In Environmental, health, and control aspects of coal conversion: an information overview. Volume 1.

Coal is a versatile energy source; it can be burned to produce heat, gasified and upgraded to possibly produce a useful pipeline gas, or liquefied to produce a fuel like a crude petroleum and used as a substitute for it. In converting coal to a gaseous fuel, sufficient hydrogen must be added to the approximately 75% carbon—5% hydrogen content ratio in coal to create a gaseous mixture that will burn with an acceptable efficiency. The problems of sulfur removal, corrosion and erosion of materials, and disposal of wastes must also be resolved. Low- and medium-Btu gasification systems vary widely in engineering design, and a single system that clearly demonstrates superiority has yet to appear. High-Btu systems involve upgrading the product to produce a high-methane gas which can be intermingled with or directly substituted for natural gas. Although successfully demonstrated in pilot plants, a catalytic methanation system has not been used in a large-scale commercial facility. Interest also has been revived in in-situ gasification of coal, where coal is ignited underground and partially gasified using pressurized air and steam. Current coal liquefaction projects are based on either pyrolysis or dissolution of the coal: Pyrolysis involves decomposition by heat of the organic substances in coal and collection of the volatile matter; the dissolution process involves dissolving coal in a suitable solvent under high temperature and pressure. Several conversion processes produce more than one type of product (fuel gas, coal liquid or a solid char). For some uses the products must be upgraded and purified or refined by methods similar to those used in refining petroleum. The status of the various projects is reviewed with the aid of flowsheets. (LTN)

9595 (ORNL/EIS—94, pp 4.1-4.157) **Process effluents: quantities and control technologies.** Dailey, N.S. Apr 1977.

In Environmental, health, and control aspects of coal conversion: an information overview. Volume 1.

Wastes are generated during each main coal conversion stage. Through technologies applied before, during, and after conversion, the largest portion (50 to 98%) of the sulfur in coal can be recovered. Lesser amounts are retained in the ash, tars, chars, or liquefaction solids, and only a small fraction is emitted to the environment. Nitrogen emissions (primarily nitrogen oxides, ammonia, and hydrogen cyanide) may be reduced by appropriate combustion techniques, operating modifications, or removal processes. Particulates and solid residues from coal conversion activities pose a potentially serious emission problem and require treatment before disposal as landfill or minefill, recycling as fuel, or sale as by-products. The fates of trace elements in coal conversion processes are not completely known. Trace element pathways may include adsorption on particulate matter, inclusion in condensates, deposition on equipment surfaces, inclusion in by-products and final products, and emission as fugitive pollutants, thus requiring development of a variety of suitable control technologies. Process wastewaters can contain components of the product gas (carbon monoxide, carbon dioxide, hydrogen, hydrogen cyanide, methane, and nitrogen) and contaminants such as sulfur and nitrogen compounds, particulates, phenols, soluble salts, and emulsified tars and oil. Wastewater treatment facilities include mechanical, chemical, and biological removal processes. Typical organic compounds that may be present in the gas, liquid, and solid waste streams include naphtha, coal tar, light and heavy oil, BTX (benzene, toluene, and xylene), solvent-refined coal, and product gases. The fate of polycyclic aromatic hydrocarbons and heterocyclic hydrocarbons is not yet known. Emissions of organics are expected, and possible means of control are being studied.

9596 (ORNL/TM—6038) **Coal Technology Program progress report, July 1977.** (Oak Ridge National Lab., Tenn. (USA)). Aug 1977. Contract W-7405-ENG-26. 54p. Dep. NTIS, PC A04/MF A01.

In hydrocarbonization research cold model tests are being conducted to determine conditions that will enhance mixing in the recirculating fluidized bed reactor and make it more suitable for the hydrocarbonization of caking coals. In the pressurized carbonization of Consol Synthetic Fuel residue, five runs were completed that show a desirably low rate of coking of the recycle solvent that is used to slurry the residue. Fracture toughness studies of thick steel plates are continuing. The effects of important welding variables such as current, travel speed, and torch oscillation on the depth of penetration and dilution of type 320 Cb stainless steel cladding

deposits have been evaluated for deposits made by the submerged-arc process. A 1000 hr exposure of heat exchanger tubes to the fluidized bed combustion conditions of a Fluidyne bed was started. Inconel 600 tubing failed by catastrophic sulfidation after a few days. In the gas-fired potassium boiler project, the major portion of the potassium piping installation was completed and connections of the electrical and instrument wiring between the control room and the system are being made. In the coal-fired alkali metal power system design study, several variations of the cycle arrangement for the selected atmospheric pressure fluidized bed combustor were completed, a preferred concept for the furnace developed, the coal feed and ash handling system was designed, and work continued on the alkali metal condenser-steam generator.

9597 (SAND—77-1072) **Instrumentation for in situ coal gasification: an assessment of techniques evaluated on the Hanna II experiment.** Northrop, D.A.; Beard, S.G.; Bartel, L.C.; Beckham, L.W.; Hommert, P.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1977. Contract EY-76-C-04-0789. 97p. Dep. NTIS, PC A05/MF A01.

The Hanna II in-situ coal gasification experiment was conducted by the Laramie Energy Research Center during 1975 to 76. Sandia Laboratories designed, fielded, and evaluated variations of seven instrumentation techniques belonging to two general classes: (a) diagnostic techniques (thermal, in-seam gas sampling and pressure, and overburden tilt and displacement) to obtain data for process characterization and (b) remote monitoring techniques (electrical, passive acoustic, and induced seismic) being developed to provide a continuous, real-time map of the in-situ process for application in a process control system. Assessments of these techniques have been made with respect to feasibility, information obtainable, and possible future development and applications. In general, very positive assessments were obtained. Extensive thermocouple arrays, which incorporated special branched circuitry for data validation, provided the most detailed characterization of in-situ coal gasification yet obtained. The feasibility of in-seam gas sampling and pressure measurements was demonstrated and composition changes due to the advancing reaction front were detailed. The thermocouple circuits and gas sampling and pressure canisters are part of a diagnostic well specification now under development for general in-situ applications. Promising results were obtained for two remote monitoring techniques. Direct excitation electrical potential and a modified Schlumberger technique. Contour maps of potential data from a surface array showed the location and movement of the reaction at 300 ft depth. Mapping the source of process-related acoustic signals was shown to be feasible. Borehole-to-borehole induced seismic techniques were able to delineate the advance of the gasification process.

9598 (UCRL—52325) **In Situ coal gasification burnfront mapping by monitoring reflected high frequency electromagnetic waves.** Davis, D.T.; Lytle, R.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Sep 1977. Contract W-7405-ENG-48. 22p. Dep. NTIS, PC A02/MF A01.

The Lawrence Livermore Laboratory and other agencies are attempting to develop efficient methods of gasifying underground coal. In-situ conversion produces a useful energy form and is economically more attractive than mining especially in western United States coal seams, which are often very deep. LLL is conducting a series of in-situ coal gasification experiments at Hoe Creek, near Gillette, Wyoming. An ability to monitor and map the burnfront during these experiments would aid significantly in analyzing and understanding the gasification process. We analyze herein the potential of monitoring the burnfront position utilizing the reflection properties of electromagnetic waves from the interface between the coal and the gasified product, using parameter values consistent with our earlier observations at Hoe Creek.

9599 **Control system for a coal gasification plant.** Gernhardt, P.; Grams, W.; Danguillier, W.; Pohl, S. (to C. Otto and Co. G.m.b.H.). US Patent 4,049,394. 20 Sep 1977. Priority date 4 Dec 1975, German, Federal Republic of (F.R. Germany). 8p.

A control system maintains a predetermined volumetric ratio between fine-particle fuel and a gasification agent which are fed separately into a reactor wherein the fuel is gasified under pressure. The control system includes a first measuring means responsive to the absorption of electromagnetic radiation by the fine-particle fuel in a fuel-feed line for producing a fuel-feed signal corresponding to the volumetric amount of fuel conducted by the line. A vehicle gas-feed signal is produced by a second measuring means in response to the volumetric amount of vehicle gas conducted by a line into the fuel-feed line for admixture with the fuel therein. Computing means is responsive to the fuel-feed signal and the vehicle gas-feed signal to produce a control signal according the expression: U_1 . (U_2 - U/sub v/) for all values of U_2 greater than U/sub v/ where U_1 corresponds to the reciprocal of the fuel-feed signal, U_2 corresponds to the vehicle gas-feed signal and U/sub v/ is a predetermined comparison signal constant. Control valves respond to the control signal to vary the volumetric amount of fuel and gasification agent introduced into the reactor.

9600 **Process and apparatus for the supply of a dry, free-flowing coal powder to a high-pressure coal gasification reactor.** Staudinger, G. (to Shell Internationale Research Maatschappij B.V.). US Patent 4,049,133. 20 Sep 1977. Priority date 24 Apr 1975, Netherlands. 8p.

Dry coal powder is fed to a high-pressure coal gasification reactor from a high-pressure chamber in inert gas. The powder is introduced in the chamber via a centrifugal pump having an inlet tube passing through a wall of the chamber and a rotor inside the chamber, which rotor throws the powder into the chamber through radial nozzles by centrifugal force. Gas leakage from the chamber through the centrifugal pump is created to prevent blockage.

9601 **High temperature methanation with molten salt-based catalyst systems.** Kiovsky, T.E.; Wald, M.M. (to Shell Oil Co.). US Patent 4,045,461. 30 Aug 1977. Filed date 15 Mar 1976. 14p.

The reaction of hydrogen and carbon oxides (carbon monoxide and carbon dioxide) to form methane at temperatures above 500°C is promoted by carrying out the reaction in the presence of a molten metal salt-based catalyst system comprising a molten metal salt carrier selected from the class consisting of the halides and carbonates of alkali metals and alkaline earth metals and the halides of zinc, copper, manganese, cadmium, tin, and iron, and mixtures thereof, melting below 1000°C; said molten salt having dispersed therein one or more catalytically active metals selected from the class consisting of iron, molybdenum, manganese, nickel, cobalt, zinc, titanium, silver, copper, and thorium in the form of finely divided elemental metals, metal oxides and/or metal carbides.

9602 **Technical, economic, and environmental evaluation of in situ coal gasifiction.** Edgar, T.F. (Univ. of Texas, Austin). *In Situ;* **1**: No. 1, 75-102(1977).

Underground coal gasification is a process which should be considered as a competitor on an economic basis with shaft mining of coal. However, not all coal seams and locations are viable candidates for the application of this technology. The important factors in site evaluation, including coal properties, geological conditions, and operating parameters, as well as the economics of underground coal gasification, are discussed. Specific reference to the Soviet system of underground gasification is given.

LIQUEFACTION

REFER ALSO TO CITATION(S) 9544, 9545, 9553, 9555, 9557, 9562, 9569, 9571, 9578, 9579, 9580, 9594, 9595, 9596, 9635, 9643, 9647, 9657

9603 (CONF-770655—3) **Experience in feeding coal into a liquefaction process development unit.** Akhtar, S.; Friedman, S.; Mazzocco, N.J.; Yavorsky, P.M. (Department of Energy, Pittsburgh, Pa. (USA). Pittsburgh Energy Research Center). 1977. 15p. Dep. NTIS, PC A02/MF A01.

From Coal feeding systems conference; Pasadena, California, USA (21 Jun 1977).

Thirty years of experience in coal liquefaction at PERC provides considerable background technology on feeding coal into pressurized units. Performance of the preferred feed system as now used serves as a basis to compare new developments. Flowable coal-oil slurry is fed by positive displacement plunger pumps into high-pressure liquefaction units. Records of over 600 hours of continuous unit operations without repairs to the feed system attest to its reliability. SYNTHOIL process development operations with slurries of various concentrations, coals, and recycle vehicle oils are reviewed. Methods for minimizing settling, plugging and erosion are discussed.

9604 (COO/4083—1) **Transfer line reactor unit for cracking of coal derived liquids. Progress report, October 1, 1976—April 30, 1977.** Shah, Y.T.; Krishnamurthy, S. (Pittsburgh Univ., Pa. (USA). Dept. of Chemical and Petroleum Engineering). Oct 1977. Contract EY-76-S-02-4083. 28p. Dep. NTIS, PC A03/MF A01.

A transfer line reactor unit built for the cracking of coal derived liquids is described in detail. Construction details for certain specific parts are provided. Results of preliminary runs obtained from the thermal cracking of hydrogenated Western Kentucky COED heavy oil are presented and discussed. Proposed initial operating conditions for the thermal cracking of hydrotreated Western Kentucky COED Light Oil are outlined. The methodology to be employed in making material balance calculations is presented.

9605 (EPRI-AF—499) **Solvent refining of West Kentucky 9-14 coal.** Nongbri, G. (Hydrocarbon Research, Inc., Trenton, N.J. (USA)). May 1977. 177p. Dep. NTIS, PC A09/MF A01.

Background information is provided on the non-catalytic solvent extraction practiced by Southern Services, Inc. at Wilsonville, Alabama. Two coals were tested: ten tests under a variety of operating conditions on West Kentucky No. 14 coal, and one test

period using Illinois No. 6 coal. The test program, which was carried out in a continuous bench-scale pilot unit, involved a total of nearly sixty days of operation. Operations at all of the experimental conditions could be sustained in solvent balance, without resort to extraneous oil, by recovering recycle solvent by vacuum distillation of the solvent contactor products. The effects of the operating conditions on the yield structure and product properties have been correlated. In general, the results of the program indicated that the pressure level (1500 psi) of the initial operation was probably the most effective pressure level. The selection of coal rate and contactor temperature would be governed by the product objectives. The degree of coal solution was only moderately sensitive to the changes in operating conditions and varied by only 1.6 wt % over the range of conditions studied. Filtration data obtained for the contactor effluent is summarized.

9606 (FE—1234-5) **Technical evaluation services coal conversion and utilization-liquefaction. Research and development report No. 82, interim report No. 5.** (Parsons (Ralph M.) Co., Pasadena, Calif. (USA)). Jul 1976. Contract EX-76-C-01-1234. 104p. Dep. NTIS, PC A06/MF A01.

An evaluation of Project Lignite activities performed at the University of North Dakota (UND), Grand Forks, North Dakota under ERDA Contract E(49-18)-1224 is presented. The evaluation includes a discussion and analysis of PDU performance to date and summarizes the results of supporting laboratory studies. Also included are an outline of planned future work, identification of potential problems, prospects for commercial operability, an assessment of SRL economics, and recommendations regarding future activities and programs to achieve ERDA objectives with existing facilities at UND. Currently, the PDU is operating at baseline conditions processing 50 lbs per hour of North Dakota lignite and producing about 58 percent SRL product on a MAF basis. The liquefaction products are being used for startup of the solid-liquid separations unit. Future PDU activities are aimed at completion of process variable studies. Recommendations are given by Parsons on the PDU activities needed to obtain adequate data for scale-up and evaluation of the economic potential of the SRL process.

9607 (FE—1517-50) **Coal liquefaction pilot plant CRESAP, West Virginia. Monthly technical progress report, April 1977.** (Fluor Engineers and Constructors, Inc., Irvine, Calif. (USA)). May 1977. Contract EX-76-C-01-1517. 29p. Dep. NTIS, PC A03/MF A01.

During this period, process startup operations are essentially complete in the following sections: Flare/Relief; Hydrogen Generation; Solvent Recovery; and Seal Oil. In addition, Sections Extraction; Fractionation; Low Temperature Carbonization, and Waste Water Treatment are all well advanced into their startup schedules. Process startup of the latter three is expected to complete within two weeks. Sections Sour Water Stripper and Gas Treatment are mechanically complete; the latter is charged with process chemicals. Further preoperational testing is awaiting definition of pertinent tests. Section Solids Separation is being prepared for operation with pre-startup fluids. In Coal Feed Preparation, minor modifications have been made to provide the necessary degree of operability. Operator checkout is being conducted to maintain familiarity with the operation. In Extraction, operational checkout of equipment has started with pre-startup fluids. In Solids Separation, inspection of mechanical equipment is complete and reinstallation is in progress. Refractory curing is complete in two of the three heaters. Plans are in preparation for closed-loop operation on a cold solvent-char slurry. Solvent recovery has been checked out with fuel oil. Fractionation has been operated on a gasoline-fuel oil mixture. Further checkout of this section is required. In Extract Hydrogenation, construction effort to correct punchlist items will commence on April 25 and is expected to complete in late May. Refractory curing of heaters is in progress. In Hydrogen Compression, chemical cleaning of compressor piping is scheduled to start April 26. Test engineering efforts have included pump inspection, preparation for evaluation of test heater performance, a checkout of filtration equipment, participation in test valve/piping inspection, and followup on corrosion/erosion requirements.

9608 (FE—1517-51) **Coal Liquefaction Pilot Plant CRESAP, West Virginia. Monthly technical progress report, May 1977.** (Fluor Engineers and Constructors, Inc., Irvine, Calif. (USA)). Jun 1977. Contract EX-76-C-01-1517. 27p. Dep. NTIS, PC A03/MF A01.

During this period, Section 200—Extraction was operated for a brief time circulating startup solvent hot. The run was terminated prematurely by failure of the extractor seals. In Section 300—Solids Separation, refractory in the third fired heater was cured. Other efforts were minimal pending completion of the construction effort. Section 700—Product Fractionation, was also operated in closed-loop, using number 2 fuel oil and gasoline as startup fluid. Startup solvent has been introduced into Section 800—Low Temperature Carbonization. Cold operation of gas recirculation and the quench loops has taken place. On May 16, all operations efforts were halted and a total plant shutdown taken to allow Construction to complete critical items in the front-end in preparation for integrated front-end startup planned for June 1. This activity will begin with closed-loop operations on startup solvent and move toward fully integrated operation on solvent and coal. Preoperational analyses have been prepared for Sections 100 and 500. Followup on test requirements is continuing.

9609 (FE—1534-49) **Chemicals from coal. Interim report for USBM Synthoil.** Peters, B.C. (Dow Chemical Co., Midland, Mich. (USA). Hydrocarbons and Energy Research Lab.). Oct 1977. Contract EX-76-C-01-1534. 88p. Dep. NTIS, PC A05/MF A01.

This document contains the results of an investigation to determine the suitability of the USBM Synthoil Product as a petrochemical feedstock. A sample of the whole crude was distilled into two straight run fractions; 350 to 650°F mid-distillate and 650°F+ residue. Laboratory studies in metal reactors and computer and mathematical simulations were performed to provide overall material balance data for a conceptual plant. The mid-distillate was hydrocracked to produce naphtha which was further processed by hydrotreating and reforming. The reformate from the mid-distillate was then mathematically hydrodealkylated to convert it to a product slate consisting of methane, LPG's, benzene, and fuel, along with the total hydrogen consumed. The value of the products obtained per 100 pounds of mid-distillate was $6.89. The high aromatic yield obtained from the hydrocrackate naphtha makes this fraction very attractive as a petrochemical feedstock. Because the gas oil would be extremely difficult to process, it was not investigated.

9610 (FE—1759-2) **Fischer—Tropsch design project capital cost validation.** (Army Engineer Div., Huntsville, Ala. (USA)). 31 Jan 1977. Contract EX-76-C-01-1759. 17p. Dep. NTIS, PC A02/MF A01.

The U.S. Army Engineer Division, Huntsville (USAEDH) has reviewed, validated, and updated a capital cost estimate of the "Commercial Complex Conceptual Design/Economic Analysis, Fischer-Tropsch Plant."R and D Report No. 114. This facility was designed to have a feed rate of 30,000 tons per day of clean coal and produce about 50,000 barrels per day of liquid products and 260 MMSCFD of synthetic natural gas. Results of the USAEDH estimate showed a fixed capital cost of $1,399 million which is less than the Parsons estimate of $1,540 million (both estimates based on March 1976 dollars). The overall confidence factor was determined to be plus or minus 10 percent. Escalation of the USAEDH estimate to mid 1976 resulted in a fixed capital cost of $1,440 million for the facility.

9611 (FE—2003-21) **Chemical characterization, handling, and refining of SRC to liquid fuels. Quarterly progress report, January—March 1977.** Greskovich, E.J.; Givens, E.N.; Collura, M.A. (Air Products and Chemicals, Inc., Allentown, Pa. (USA). Corporate Research Dept.). May 1977. Contract EX-76-C-01-2003. 61p. Dep. NTIS, PC A04/MF A01.

Results from hydroprocessing of solvent refined coal (SRC) over two commercially available catalysts are presented. By making simplifying assumptions regarding the chemistry of the conversion process, we calculate that over 40% of the consumed hydrogen goes to upgrade feed solvent to recycle solvent. The effect of hydrogen consumption on oxygen removal is discussed for CP3 where numerous conditions were evaluated. A hydrogen consumption to oxygen elimination ratio of 7/1 was observed. Similar ratios apply to both the 750 - fraction and he 750 + fraction. Results from gas-liquid chromatographic analysis of recycle solvent are presented. Dimethylindane and methylfluorene are two materials of unusual interest. Results from the high pressure liquid chromatography (HPLC) of the 750 + products are presented. Hydrotreated products have additional fine structure in the 200 (pyrene) to 300 mw (coronene) range which is absent in the corresponding fractions in the feed. Additional data on CP5 will be available in subsequent reports.

9612 (FE—2031-8) **Chemistry and structure of coal-derived asphaltenes. Phase II. Quarterly progress report, April—June 1977.** Schwager, I.; Farmanian, P.; Kwan, J.; Lee, W.C.; Miller, J.; Lew, R.; Louie, M.; Wong, M.; Yen, T.F. (University of Southern California, Los Angeles (USA)). Oct 1977. Contract EX-76-C-01-2031. 48p. Dep. NTIS, PC A04/MF A01.

Separation of coal asphaltenes by solvent elution chromatography with benzene, diethyl ether, and tetrahydrofuran, on silica gel, may be carried out to obtain distinct fractions with 98 to 99 percent recovery of starting asphaltene. The diethyl ether eluted fraction is found to be more basic and polar, to have a higher degree of saturation, and to contain smaller average aromatic π-systems than the benzene eluted asphaltene fraction. The third fraction (THF-eluted) has the highest molecular weights, and the largest percentages of nitrogen and oxygen. Donor-acceptor complexes between coal asphaltenes and the π-acceptor tetracyanoethylene have been synthesized. UV-visible spectra of these species show new charge-transfer absorption bands not found in the free components. Electron spin resonance measurements show enhanced spin signals for these complexes. X-ray diffraction measurements indicate solid state clusters of asphaltene/TCNE in the range of $^3/_2$ to $^4/_2$. Elec-

tron spin resonance spectra of asphaltenes, asphaltene chromatography fractions, and asphaltene charge transfer complexes afford relative ESR signal intensity values consistent with a picture of donor-acceptor properties holding alternate layers together.

9613 (FE—2044-19) **Partial liquefaction of coal by direct hydrogenation. Seventh quarterly progress report, January—March 1977.** Oberg, C.L. (Rockwell International Corp., Canoga Park, Calif. (USA)). Sep 1977. Contract EX-76-C-01-2044. 12p. Dep. NTIS, PC A02/MF A01.

Fifteen tests were made in the 1 TPH reactor system. Four tests were required to complete shakedown of the new facility. Good results were obtained from the subsequent tests and the system operated well. Tests were made with reactor residence times varying from 45 to 634 milliseconds with up to 1478 lbm of coal being processed in a 1-hour long test. Reactor pressure was varied from 700 to 1500 psig. The test results, being analyzed currently, indicate overall carbon conversions up to 64 percent and conversions to liquids up to 35 percent.

9614 (FE—2044-22) **Partial liquefaction of coal by direct hydrogenation. Quarterly progress report, April—June 1977.** Oberg, C.L. (Rockwell International Corp., Canoga Park, Calif. (USA). Rocketdyne Div.). Sep 1977. Contract EX-76-C-01-2044. 32p. Dep. NTIS, PC A03/MF A01.

The initial series of 1 TPH reactor tests was completed on April 4, 1977. During this test 1013 lbm of coal was processed in 37 minutes at 1000 psig and 1690°F. Data from this initial test series were analyzed. Material balances were calculated for carbon, hydrogen and ash. Sulfur and nitrogen contents and heating values of the product char were correlated. The compositions and heating values of the liquid product recovered from the condenser were summarized. In a concurrent effort, a dense-phase flow, char removal system was installed under company funding. Approval to resume testing in the 1 TPH unit was received early in June. A packed bed adsorber was installed for these tests to recover entrained and vapor-phase liquid product from the gas stream. Three additional 1 TPH tests were made by the end of the quarter. The test results are still being analyzed but material balance calculations for the first of the latter tests showed essentially complete carbon and ash recovery (102% indicated recovery on each).

9615 (FE—2202-5) **Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Quarterly report No. 5, November 1, 1976—January 31, 1977.** (Stanford Research Inst., Menlo Park, Calif. (USA)). 8 Mar 1977. Contract EX-76-C-01-2202. 56p. Dep. NTIS, PC A04/MF A01.

A study of the effect of higher reaction temperature (300°C) on treatment of coal with the $AlCl_3$/HCl catalyst system showed that with a 2/1 catalyst/coal weight ratio, the coal is almost entirely gasified, with 40% of the C converted to CH_4, and 50% to C_2H_6. The study of the importance of adding of HCl to the reaction system at this temperature showed that without added HCl, the gas yield was significantly reduced, and the H/C atomic ratio of the coal residue also decreased considerably. A study was made on the effects of several variables on coal conversion in i-PrOH and KOiPr at 335°C for 90 min. Decreasing the reaction time to 30 min virtually eliminated the conversion. Interactions of coal with Tetralin and naphthalene were studied. When treated with Tetralin at 430°C, Illinois No. 6 coal yields a product with pyridine solubility increasing from 80 to 97% when contact time is increased from 28 to 137 sec. Pyridine solubility of coal treated with naphthalene was determined as a function of contact time at 400 and 430°C. For the former, the initial conversion is 20%, rising to approximately 40% in 2 min. The extension of group additivity procedures to the estimation of thermochemical data for coal-related nitrogen-containing heterocycles has begun. The very low-pressure pyrolysis system has been modified to enable measurement of the stabilities of benzyl radical analogs that are likely intermediates in thermolytic reactions of coal. The system is now being calibrated. A summary is presented of new and older work on fractionation of coal extracts and SRCs. Number-average molecular weights of these fractions have been related to retention volumes of the same fractions in gel permeation chromatography in tetrahydrofuran.

9616 (FE—2244-11) **Flash pyrolysis coal liquefaction process development. Quarterly report for January—March 1977, including the March 1977 monthly report.** Kneel, E.W.; Gethard, P.E.; Shaw, B.W.; Green, N.W.; Qader, S.A. (Occidental Research Corp., La Verne, Calif. (USA)). Oct 1977. Contract EX-76-C-01-2244. 80p. Dep. NTIS, PC A06/MF A01.

Two extended baseline runs with subbituminous coal were completed this quarter each of which ran for about 120 hours. A material balance is reported for the first run. A pyrolysis kinetics model has been developed. Significant quantities of BTX and phenols in the light fraction of full-range tar have been found. Operability of the hydrotreater has been demonstrated with Arabian vacuum gas oil and PDU-produced tar.

9617 (FE—2245-9) **Research on cross-flow filtration for solids removal from coal syncrudes. Quarterly technical progress report, September 1—November 30, 1976.** Tompkins, F.C. Jr. (Abcor, Inc., Wilmington, Mass. (USA). Walden Div.). Sep 1977. Contract EX-76-C-01-2245. 21p. Dep. NTIS, PC A02/MF A01.

System construction activities are complete through Task 46 of the PERT diagram, with the remaining two tasks underway. Temporary replacement seals for the main process pump have been supplied by the manufacturer and should allow the initiation of the test protocol. As indicated in previous reports, a unique approach to the measurement of feed and filtrate flow rates has been proposed for this investigation. Due to the nature of SRC and the filtration process, significant changes in fluid properties can be expected (solids loading, viscosity, density) to occur during processing. Thus, traditional flow measurement devices (rotameters, orifice meters, etc.) can be expected to yield only a qualitative indication of actual flow rates at best. Diversion of a process stream with collection over a measured time interval and subsequent weighing represents an improvement in flow indication, but requires assessment of density to yield accurate flow rates. A true volumetric flow indicator, insensitive to changing fluid properties, appears to be desirable. The approach to be taken in this investigation for flow measurement is the periodic diversion of the process stream to be measured into a calibrated volume, with the volumetric throughput followed by means of a capacitance level-indicating probe with associated electronics. By following the progress of the SRC/nitrogen interface for a known time interval, an exact indication of volumetric flow rate (independent of fluid properties) should be obtained. To date, the capacitance probes with required electronics have been received and assembled. Preliminary performance evaluations have been carried out to confirm the applicability of the measurement principle.

9618 (FE—2270-15) **Solvent refined coal (SRC) process operation of solvent refined coal pilot plant at Wilsonville, Alabama. Annual technical progress report, January—December 1976.** Lewis, H.E.; Weber, W.H.; Usnick, G.B.; Hollenack, W.R.; Hooks, H.W. (Catalytic, Inc., Wilsonville, Ala. (USA)). Jun 1977. Contract EX-76-C-01-2270. 233p. Dep. NTIS, PC A11/MF A01.

Operating conditions and results for the six-ton-per-day Solvent Refined Coal (SRC) pilot plant at Wilsonville, Alabama, are presented. Conditions and results for the entire year are summarized. Results from Wilsonville were correlated with the 50-ton-per-day Ft. Lewis pilot plant operation. This correlation was established processing Kentucky 9 and 14 coal. A second objective was to determine the effect of process variables on yield and quality when processing other coals. This was completed for Monterey (Ill. 6) and was continuing into 1977 for Amax Belle Ayr coal. The effects on the operation of varying the boiling range of the process solvent and the dissolver volume are reported. Also reported are the effects of operating variables on the overall plant solvent inventory balance. Filtration results show that the filter cake from Amax Belle Ayr coal has a lower resistance, but is more compressible, than the filter cake from either the Kentucky 9 and 14 or the Monterey (Ill. 6) coals. Results from testing of alternative methods for mineral residue separation, such as centrifuges, hydroclones, are described. Background information is reported for installing a system for preliminary evaluation of an antisolvent method for improvement of the mineral residue separation systems. SRC containing less than 0.16 percent ash, 0.96 percent sulfur was produced from each coal processed during the year. An SRC solidifier, which uses indirect cooling, was developed and the capacity of the machine has been defined. Several alternative methods of solidification were also investigated.

9619 (FE—2307-21) **Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (Riser Cracking of Coal). First quarter report, April 1—June 30, 1977.** Duncan, D.A.; Beeson, J.L.; Oberle, R.D. (Institute of Gas Technology, Chicago, Ill. (USA)). Aug 1977. Contract EX-76-C-01-2307. 27p. Dep. NTIS, PC A03/MF A01.

Fourteen runs were made in the bench-scale unit using system outlet pressures of 1500 and 2000 psig, coil outlet temperatures of from 1400° to 1500°F, and solids levels in the feed stream of 88 percent and 67 percent by weight. In all runs, the solids residence time above 1300°F was approximately 2 seconds. Several runs of 2-hours duration were made without difficulty, and sufficient hydrocarbon liquids were produced for detailed chemical analysis. The hydrogen feed was not superheated with respect to the coal in these runs, as it will be in the next series. The conversion levels were in the 40 to 50 percent range. The main products of the reaction system, particularly the hydrocarbon oils, have been characterized; maximum liquids production of just over 12 weight percent takes place at a coil outlet temperature between 1400 and 1500°F. Upon distillation, about 45 percent of the main liquid product reports to the gasoline fraction, which upon analysis has been found to contain substantial amounts of benzene, toluene, xylene, and other high-octane blending stock constituents. Light gases are also produced that, on the hydrogen-free, carbon oxide-free basis, are approximately 70 mole percent methane, 20 mole percent ethane, and minor

amounts of ethylene and propylene. The ethane is sufficiently abundant to warrant consideration of recovery of the ethane for use as a chemical feedstock.

9620 (FE—2335-10) **Catalyst development for coal liquefaction. Interim report, January—March 1977.** Hindin, S.G. (Engelhard Minerals and Chemicals Corp., Murray Hill, N.J. (USA). Engelhard Industries Div.). May 1977. Contract EX-76-C-01-2335. 38p. Dep. NTIS, PC A03/MF A01.

The autoclave screening unit has been shaken-down and shown to yield reproducible data. The coal-feeder performs very well, and discharges of the order of 99+ percent of the coal charged. Preliminary data suggest that conversion to benzene-soluble products may not distinguish among catalysts. A rough calculation of the apparent energy of activation, about 20 kcal., would indicate that the screening system is not limited by gas/liquid or liquid/solid mass transfer. Sulfur analyses of coal liquefaction products by combustion analysis may yield results differing from those obtained on the 240 Analyzer. Adsorption of pyridine and ammonia on supports do show "acidities" varying with the method of preparation and pretreatment. Such catalysts will be used to determine if a correlation exists between such measurements and actual coal conversion tests. Reactor modification is proceeding on schedule; the task will be completed by the contract date.

9621 (FE—2494-2) **Relation of coal characteristics to liquefaction behavior. Quarterly technical progress report, October—December 1976.** Given, P.H.; Spackman, W.; Davis, A.; Walker, P.L.; Lovell, H.L.; Coleman, M. (Pennsylvania State Univ., University Park (USA)). Oct 1977. Contract EX-76-C-01-2494. 66p. Dep. NTIS, PC A04/MF A01.

There are reasons for believing that cleavage of ether bonds may be a crucial step in the mechanism of coal liquefaction. On a mechanistic scheme this hypothesis has been set up, and mathematically modelled by means of three differential equations. Using the integrated equations, the three rate constants have been determined from a least squares fit of published data. The correlations between measured and predicted conversions are excellent. Plots of the logarithms of the rate constants versus 1/T indicate that at the higher temperatures diffusion is an important rate-controlling step. In a study concerned with physical aspects of the interaction of solvents with coals, it was found that usually the amount of benzene adsorbed increased with increasing relative vapor pressure and temperature, as expected for activated diffusion. However, some coals showed anomalous behavior. Since the conventional separation of coal liquids into "oil" and "asphaltene" does not give a clean separation by either compound type or molecular size, a new primary separation based on size alone has been developed, depending on separation on a gel having molecular sieve properties. The effectiveness of the separation has been checked by high pressure liquid chromatography. The heavier fraction from this separation has been subjected to conditions that convert phenols to their trimethylsilyl derivatives. A major increase in solubility in non-polar solvents results, and the changes in 1H nmr spectra on silylation include the appearance of two bands due to protons in $-Si(CH_3)_3$ and the splitting of the band for the coal aliphatic H into two bands. The procedure being developed for the qualitative and quantitative analysis of minerals in coals based on Fourier Transform Infrared Spectroscopy, is nearly ready for routine use. However, obtaining good values for quartz is still giving trouble.

9622 (FE—2550-3) **Physical and chemical behavior of liquefied coal in solids separation. Quarterly report, April—June 1977.** Briggs, D.E.; Addington, D.V.; Cameron, J.R. (Michigan Univ., Ann Arbor (USA)). Jul 1977. Contract EX-76-S-01-2550. 32p. Dep. NTIS, PC A03/MF A01.

Four α, ω-bis-(hydroxyphenyl) alkanes and four α, ω-dipyridyl or diquinolyl alkanes were synthesized and purified to yield crystalline solids to provide model asphaltene components. These compounds could account for the middle-field portion of asphaltene NMR spectra. Neutron activation was used to measure the metal contents of liquefied coal residues, extracts and GPC fractionated samples. Repairs and modifications to the filtration equipment were completed and recalibration of differential pressure instruments begun. The design of a sample holder and cell for small angle x-ray scattering experiments to measure the size-configuration of asphaltene colloids was completed and cell manufacture begun. Experimental equipment to measure the electrical conductivity and dielectric constants of asphaltene solutions was calibrated. Adsorption equilibrium data between an asphaltene in nitrobenzene and alumina were obtained. Asphaltene adsorption from pyridene onto alumina at equilibrium concentrations up to 25 weight percent were taken. Streaming potential measurements were begun for the flow of asphaltene solutions through fixed beds. The effect of drying and heating on the viscosity of an asphaltene fraction was examined.

9623 (FE—2566-07) **Upgrading of coal liquids. Monthly technical progress report for September 1977.** Tan, G.; deRosset, A.J. (UOP, Inc., Des Plaines, Ill. (USA)). Oct 1977. Contract EF-77-C-01-2566. 32p. Dep. NTIS, PC A03/MF A01.

Second-stage hydrocracking, aimed at 100 percent conversion of low nitrogen H-Coal liquid to naphtha, was concluded with studies at 500 psig above base pressure. An attempt to hydrocrack rerun H-Coal atmospheric bottoms to fuel oil in a single-stage recycle operation was not successful. Maximum conversion to fuel oil was below 100 percent. Second-stage hydrocracking of a $600^{\circ}F^{+}$ fraction of H-Coal hydrocrackate over UOP-DCB catalyst showed no significant conversion to fuel oil. Similar operation over UOP-HCA catalyst indicate that 100 percent conversion of $600^{\circ}F^{+}$ liquid to fuel oil was attained. Work on evaluating the activity of three commercial UOP catalysts for hydrogenating the H-Coal distillate was completed. A hydrotreating catalyst has been selected for FCC studies. Platforming runs with upgraded EDS process naphtha and two H-Coal hydrocracked naphthas have been completed.

9624 (FE—2574-2) **Research studies for producing liquids by short residence time coal hydropyrolysis. Monthly progress report, August 1977.** Greene, M.I. (Cities Service Research and Development Co., Cranbury, N.J. (USA)). 1977. Contract EF-76-C-01-2574. 21p. Dep. NTIS, PC A02/MF A01.

On the basis of bench scale tests a high volatile C bituminous coal was chosen for Tasks 1B, 2 and 3. The coal was obtained from the Big Ben Mine, Lucas County, Iowa, with the help of the Iowa State Geological Survey. Pulverization and drying of the coal is being performed at the Pittsburgh laboratories of the United States Bureau of Mines. Evaluation and design of the reactor geometries required for the tests of Tasks 1-4 has been made. Initial testing in the one-inch glass column has indicated that in the free-fall reactor, there is essentially no effect of coal mass flux on the net terminal velocity of coal particles. Solicitation of subcontractors for preparing the catalyst-on-coal samples required in Task 3 and 4 is continuing.

9625 (FE—2893-7) **EDS coal liquefaction process development, Phase III B. Monthly technical progress report, July 1—August 31, 1977.** (Exxon Research and Engineering Co., Linden, N.J. (USA)). 1977. Contract EF-77-A-01-2893. 48p. Dep. NTIS, PC A03/MF A01.

The process variable study initiated during Phase IIIA with Wyoming subbituminous coal was resumed in the 50 pound-per-day Recycle Coal Liquefaction Unit. The variables investigated were liquefaction residence time and temperature. Studies on the one ton-per-day Coal Liquefaction Pilot Plant continued with Wyoming subbituminous coal to obtain additional yield information at longer residence times than those previously tested. Bituminous coal operators were then resumed to study the effects of increasing the end-point of the solvent. There were no operational problems and there were no apparent yield differences between the standard solvent and the higher end-point solvent. A high molecular weight cationic flocculant effectively settled both Illinois and Wyoming coal fines from a water slurry. This additive may be used in the disposition of coal fines from the 250 ton-per-day Exxon Coal Liquefaction Pilot Plant to an existing refinery solids settling pond. Analyses of fines from studies in the Fluidized Bed Unit showed the ash content of the -325 mesh material to be consistently greater than 99 wt percent. Coke gasification levels varied from 70 to 90 percent in these studies. The integrated coking gasification unit was prepared for integrated operation on Illinois coal bottoms from CLPP. An engineering evaluation of alternative processes for hydrogen manufacture indicated that the choice of the preferred route is dependent on the value of high BTU gas and the cost of plant fuel gas.

9626 (FE—22002-20) **Homogeneous catalytic hydrocracking processes for conversion of coal to liquid fuels: basic and exploratory research. Monthly report No. 20, June 1977.** (Stanford Research Inst., Menlo Park, Calif. (USA)). Jun 1977. Contract EX-76-C-01-2202. 15p. Dep. NTIS, PC A02/MF A01.

The homogeneous acid catalysis work has been terminated, and efforts are concentrated on other potential processes for converting coal to distillable liquids. The coal conversion potential of the suspended heterogeneous catalyst system and homogeneous base catalysis have been examined. CaO was found to be a moderately effective catalyst for the MeOH/coal reaction. The interactions of Illinois No. 6 coal with phenol and with a 50-50 mixture of phenol and Tetralin at 400°C for reaction times ranging from 30 sec to about 4 min have been studied. Work is continuing on the measurement of the rate of bond cleavage of 1-ehtylnaphthalene, including verification of previous rate data for ethylbenzene decomposition. The reaction has proved to be more complex than anticipated at the high pressure end of the VLPP range.

9627 (NBS-SP—468, pp 107-120) **Erosion problems in letdown valves.** Mueller, J.J. (Battelle Columbus Labs., Columbus, OH). Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

The coal-derived slurries associated with all types of liquefaction processing present serious wear problems for many of the system components. In particular, the throttling valves used to let down the ash-containing slurry from the high processing pressure to near-ambient pressure experience relatively short service life as a result of erosive wear of the internal components. The wear life of cemented carbide trim components in pilot facilities ranges from only about 2 weeks to 2 months. Other components of the valve body have lasted only a few days when not properly protected from direct impingement by the rapidly moving slurry. Design modifications are continually being made to minimize the wear problem and thereby lengthen the time between component changes. The design of trim components is discussed and examples are presented of worn components and some of the valve design modification which have been evaluated. Wear of the critical cemented carbide trim components is shown to occur by the mechanism of removal of the soft metal matrix from between the hard, wear-resistant carbide particles, and the associated pullout of the hard particles. Improvement in the life of trim components is expected to come with minimized metallic binder content or adoption of hard, single-phase ceramic materials.

9628 (NSF-AER—7515213) **Studies on the separation of coal extract from solid residue in liquefied coal.** Briggs, D.E.; McAlpine, D.B.; Bedford, C.D. (Michigan Univ., Ann Arbor (USA)). Sep 1977. 458p. Dep. NTIS, PC A20/MF A01.

Coal liquefaction residues from the SYNTHOIL (Pittsburgh Seam) and H-Coal (Illinois No. 6) processes were fractionated by solvent extraction into oils and resins, asphaltenes, preasphaltenes, and mineral solids for adsorption, filtration, surface tension, and viscosity measurements. Suspended solids in liquefied coal range in size from less than 0.05 μ to greater than 1 μ. The specific resistance of filter cakes varies as an inverse function of the number average particle size. THF insoluble solids from SYNTHOIL product oil, H-Coal vacuum still bottoms and SYNTHOIL centrifuge cake had number average particle sizes of 0.067, 0.071, and 0.147 μ, respectively. When filtered from tetralin at 177°C, the specific resistances were 0.7×10^{12}, 0.6×10^{12}, and 0.31×10^{12} m/kg, respectively. At temperatures below 200°C, the H-Coal filter cake compressibility was 0.36. The specific filtration resistance is temperature dependent above 200°C, being from 50 to 100 percent higher at 232°C than at 177°C. Surface tension and reduced viscosity data for oils, resins, and asphaltenes in tetralin indicate intermolecular association and colloid micellization. At asphaltene and preasphaltene concentrations about 15 percent, micelle formation is significant. The micelles interact with porous media through which they flow to give an increase in cake resistance of 40 to 100 percent, depending on the size of the micelles in relation to the size of the flow passages. Resins act to peptize the micelles, which limits their size.

9629 **Coal liquefaction process.** Plumlee, K.W.; Vernon, L.W. (to Exxon Research and Engineering Co.). US Patent 4,049,536. 20 Sep 1977. Filed date 17 May 1976. 8p.

A process for liquefying a particulate coal feed to produce useful petroleum-like liquid products by steps which include: (a) admixing said coal feed, a solvent, particularly a non-donor solvent, and an ortho-quinone compound, to form a coal liquid slurry, and then (b) contacting said coal liquid slurry with molecular hydrogen in a liquefaction zone at temperature and pressure sufficient to hydroconvert and liquefy the coal. In accordance with a preferred embodiment, the product from the liquefaction zone is separated by distillation into fractions inclusive of fractions boiling within about the 350 to 850°F. range, and preferably within about the 400 to 700°F. range, which can be recycled to the coal liquefaction zone for use in slurrying the coal. The ortho-quinone compound acts as a hydrogenation catalyst, causing adequate hydrogenation of the coal within the coal liquefaction zone in the presence of the molecular hydrogen without any necessity of employing a hydrogen donor solvent, and hence there is no necessity for hydrogenation of the solvent in a separate hydrogenation zone.

9630 **Liquefaction of coal.** Green, R.C.; Dubell, R.L. (to Exxon Research and Engineering Co.). US Patent 4,048,054. 13 Sep 1977. Filed date 23 Jul 1976. 14p.

In a coal liquefaction process wherein feed coal is contacted with molecular hydrogen and a hydrogen-donor solvent in a liquefaction zone to form coal liquids and vapors and coal liquids in the solvent boiling range are thereafter hydrogenated to produce recycle solvent and liquid products, the improvement which comprises separating the effluent from the liquefaction zone into a hot vapor stream and a liquid stream; cooling the entire hot vapor stream sufficiently to condense vaporized liquid hydrocarbons; separating condensed liquid hydrocarbons from the cooled vapor; fractionating the liquid stream to produce coal liquids in the solvent boiling range; passing the cooled vapor, the coal liquids in the solvent boiling range, and makeup hydrogen to the solvent hydrogenation zone as feed to the hydrogenation zone; and thereafter catalytically hydrogenating the hydrogenation zone feed stream while quenching the hydrogenation reaction with fluids recovered from the hydrogenation zone effluent.

9631 **Coal hydrogenation with selective recycle of liquid to reactor.** Johanson, E.S.; Wolk, R.H. (to Hydrocarbon Research, Inc.). US Patent 4,045,329. 30 Aug 1977. Filed date 28 Nov 1975. 8p.

Coal is hydrogenated in an upflow, random motion, gas-liquid-catalyst process in which the heavy liquids (800 to 1000°F) are recycled to the reactor to optimize production of preferred 400 to 800°F boiling range end product liquids. The optimization is accomplished by not recycling to the reactor any liquid fraction boiling between about 600 and 800°F.

9632 **Production of hydrogenated coal liquids.** Green, R.C.; Dubell, R.L. (to Exxon Research and Engineering Co.). US Patent 4,045,328. 30 Aug 1977. Filed date 23 Jul 1976. 16p.

In a coal liquefaction process wherein feed coal is contacted with molecular hydrogen and hydrogen-donor solvent in a liquefaction zone to form coal liquids and vapors and coal liquids in the solvent boiling range are thereafter hydrogenated to produce recycle solvent and liquid products, the improvement is described which comprises separating the effluent from the liquefaction zone into a hot vapor stream and a liquid stream, combining a portion of the hot vapor stream with makeup hydrogen and with coal liquids in the solvent boiling range, passing the combined vapor, hydrogen and coal liquids to the solvent hydrogenation zone as feed to the hydrogenation zone, discharging the remainder of the vapor stream as purge after cooling to recover vaporized hydrocarbons and removing contaminants, and thereafter catalytically hydrogenating the hydrogenation zone feed stream while quenching the hydrogenation reaction with fluids recovered from the hydrogenation zone effluent.

PYROLYSIS AND CRACKING

REFER ALSO TO CITATION(S) 9541, 9624, 9626

9633 **Gav generation apparatuses and processes.** Patton, C.E. (to Blue Ember Flame Corp.). US Patent 3,933,618. 11 Mar 1974. vp.

An apparatus for generating combustible gas mixtures and liquid gasoline from coal is described comprising, in operative combination, a retort assembly, a washer assembly, a condenser assembly, a pump and storage assembly, and a heating assembly. The retort assembly comprises a gas-tight retort tank and a hood; the gas-tight retort tank comprises a horizontally extending rigid imperforate cylindrical wall and one vertically extending side wall firmly attached on one side, and another side wall removably yet firmly attached to another side of the cylindrical wall. The washer assembly comprises a cooling coil and a washer tank, the cooling coil comprising a vertically extending coil, one lower end of which is operatively attached to the retort discharge channel and the other, discharge, end of the cooling coil operatively attached to the washer tank. The condenser assembly comprises a condenser and a collection tank. The condenser is connected via a vertically extending tube to the collection tank, which has an upper discharge outlet and a lower discharge outlet. The pump and storage assembly comprises a pump and a first storage tank, the collection tank upper discharge line connected via the gas treatment chamber to the inlet of the pump. (JRD)

SOLVENT EXTRACTION

REFER ALSO TO CITATION(S) 9612, 9716

9634 (FE—2038-14) **Commercial scale expanded bed hydroprocessing of solvent refined coal (SRC) extract. July monthly technical progress report.** Potts, J.D. (Cities Service Co., Tulsa, Okla. (USA). Technology Assessment Dept.). Aug 1977. Contract EX-76-C-01-2038. 14p. Dep. NTIS, PC A02/MF A01.

The base case catalyst screening run on unmodified American Cyanamid 1442B cobalt-molybdenum catalyst has been completed. Two hydrogenated Koppers Heavy Residue Creosote Oil solvents were employed in the 50/50 SRC/solvent feed blends—a 400°F and a 500°F IBP solvent with the 400°F solvent being run first. No significant differences in conversion and denitrogenation were noted for the two solvents. Following an initial high conversion of 77 weight percent of 850°F+ material, the conversion remained approximately constant at 65 weight percent from Period 5 through Period 12 (a change in solvent occurring at Period 7/8). The hydrogen content of the heavy oil through the same periods was approximately 7.5 weight percent (6.35 weight percent in the two SRC/solvent feed blends). When processing the 400°F IBP solvent, the denitrogenation activity of the catalyst declined steadily from 61.3 to 50.4 percent. With the 500°F IBP solvent, the denitrogenation activity declined from 55.8 to 39.5%.

9635 (NBS-SP—468, pp 191) **Low ductility, high temperature failure of austentic materials.** Hamel, F.B. (Gulf Science and Tech. Co., Pittsburgh). Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

An interesting and pertinent problem that has been seen several times involves low ductility intergranular fracture of austenitic alloys operating in the 1100 to 1200°F temperature range. One specific problem was a crack that developed in a ten inch Incoloy 800 type 2 transfer pipeline. Incidentally, this piece of piping was made of rolled plate that was manufactured in England. It was shipped to a fabricator in France who rolled it into pipe sections and welded it. It went to another fabricator in France for fabricating into a piping detail. From there it went to a unit in Spain.

9636 (NBS-SP—468, pp 192-194) **SRC plant.** Samuels, L.G. (SRC Plant, Tacoma). Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

The SRC (solvent refined coal) plant at Tacoma, Washington is a 50 tpd (feed rate) pilot plant located on Fort Lewis, Washington. Construction began July, 1972 and was completed in the summer of 1974. The first coal was introduced September 30, 1974. The first year of operation was spent making material balance runs at different conditions of reaction flow, residence time, pressure, and temperature and sorting out other reaction area parameters. In September, 1975 a concerted effort to produce 3000 tons of SRC for a burn test was begun. The first four months of this production run resulted in approximately 100 tons per month production due to mechanical problems in the filtration area and processing problems in the solvent fractionation areas. During February, 1976 approximately 500 tons of SRC was produced and during March production amounted to about 400 tons. Improvement to 500 or 600 tons per month now seems possible.

BY-PRODUCTS

9637 (FE—1724-30) **Utilization of coal conversion process by-products. Quarterly report, March 26, 1977—June 25, 2977.** Solomon, I.J.; Giori, C. (IIT Research Inst., Chicago, Ill. (USA)). Jul 1977. Contract EX-76-C-01-1724. 12p. Dep. NTIS, PC A02/MF A01.

The preparation of 1 lb. of char acids designated as char acid No. C-2, has been successfully completed. It has been titrated potentiometrically and found to possess a carboxyl group concentration of 1.31 x 10^{-2} eq/g, which is comparable to previously synthesized char acids. Polymer molding experiments were conducted by using polyesters prepared earlier from char acid No. C-1 using a weight ratio C-1/TEG bottoms of 1 : 1.5 and 1 : 2 respectively. Later, when the C-2 char acid became available, several polyester resins were prepared at char acid/TEG ratios of 1 : 1, 1 : 1.5 and 1 : 2. These samples were utilized for the preparation of microtensile bars for testing of mechanical properties. The results obtained are very encouraging. All of the materials tested exhibited high elongation but relatively low tensile strength. The feasibility of using char acid polyesters in glass reinforced composite structures was investigated and showed considerable promise. In addition, a study of the synthesis of polyurethane foams has been initiated. This involves the reaction of a diisocyanate with the same type of char acid polyesters currently being utilized for the synthesis of thermosetting resins. Techniques for the analysis of carboxyl and hydroxyl end-groups and water content were developed and utilized in this work.

PROPERTIES

REFER ALSO TO CITATION(S) 9541, 9609, 9612, 9621, 9658, 9662, 9670, 10742

9638 (ANL/CEN/FE—77-4) **Study of the volatility of minor and trace elements in Illinois coal.** Lee, S.H.D.; Johnson, I.; Fischer, J. (Argonne National Lab., Ill. (USA)). Aug 1977. Contract W-31-109-ENG-38. 27p. Dep. NTIS, PC A03/MF A01.

The volatility of fifteen minor and trace elements in Illinois Herrin No. 6 seam coal in the temperature range from 540 to 1250°C was investigated under dry and humidified combustion conditions. Data indicate that under the dry oxidizing conditions, almost all of the chlorine in the coal evolves at 640°C, although trace amounts of chlorine still remain in the high-temperature ashes. The metallic elements, Na, K, Fe, Al, Mg, Ca, Ti, Zn, Mn, Ni, Cu, Cr, Li, and V are generally retained in the ash up to 1250°C in both dry and wet oxidizing environments, and the retention of these metallic elements in the ash is not affected by the oxygen concentration in the dry combustion gas. Both water vapor and the oxygen-enrichment in the combustion air cause a greater total weight loss than that in the dry combustion air.

9639 (FE—2030-TR3) **Effects of heat treatment conditions on reactivity of chars in air.** Ashu, J.T.; Walker, P.L. Jr. (Pennsylvania State Univ., University Park (USA). Coal Research Section). Sep 1977. Contract EX-76-C-01-2030. 55p. Dep. NTIS, PC A04/MF A01.

Reactivities of chars are maximized by keeping heat treatment temperatures as low as possible, minimizing soak time at maximum HTT and maximizing heating rates. It is feasible to use reactivity parameters as a tool for the study of thermal history of carbonaceous materials. Maximum HTT as well as the heating rate used for char preparation seem to be more important parameters in influencing char reactivity than the atmosphere used during preparation. Aging of chars in air following heat treatment at 800°C has little or no effect on subsequent char reactivity. The most significant conclusion of this investigation is that rapid heating results in significant increase in char reactivity to air. Surface areas of rapidly heated samples are significantly higher than those prepared at the same temperature using slower heating rates.

9640 (FE—2286-21) **Preparation of a coal conversion systems technical data book. Project 8979 monthly status report, August 1—August 31, 1977.** (Institute of Gas Technology, Chicago, Ill. (USA)). Oct 1977. Contract EX-76-C-01-2286. 50p. Dep. NTIS, PC A03/MF A01.

Various correlations for estimating the calorific value of coal from its elemental composition are compared using an extended data base of American coals. Charts that give partial pressures of NH_3 and H_2S in the NH_3-H_2S-H_2O subsystem are presented. The equilibrium constants for reactions of interest in coal conversion processes are presented as functions of temperature. Three correlations for saltation velocity in horizontal gas-solid transport are evaluated using available data on saltation velocities. Experimental and calculated fluid temperature profiles in coal-slurry heaters are compared for a low solvent to coal ratio (S/C = 1.69). Heat transfer coefficient curves (calculated using three different heat transfer correlations) are presented as functions of temperature for various solvent/coal ratios and fluid velocities.

9641 (IS—4251) **Evaluation of pyrite particle size, shape, and distribution factors for coal channel samples.** Greer, R.T. (Iowa State Univ. of Science and Technology, Ames (USA)). 1977. Contract W-7405-ENG-82. 3p. (CONF-770821—2). Dep. NTIS, PC A02/MF A01.

From EMSA meeting; Boston, Massachusetts, USA (Aug 1977).

The size and nature of pyrite crystals in coal has been examined by electron microscopy, with the view of assessing the potential for desulfurization at various stages of grinding (especially after grinding to approximately 200 mesh size which is often done just prior to combustion). (LTN)

9642 (LA—6933-PR) **Trace element characterization and removal/recovery from coal and coal wastes. Progress report, October 1—December 31, 1976.** Wewerka, E.M.; Williams, J.M.; Vanderborgh, N.E.; Wagner, P.; Wanek, P.L.; Olsen, J.D. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1977. Contract W-7405-ENG-36. 62p. Dep. NTIS, PC A04/MF A01.

The quantitative analyses of the trace elements in bulk refuse and coal samples from three Illinois Basin coal preparation plants have been completed and the data compiled. Calibration of the x-ray diffractometer with standard minerals has been done, and the quantitative mineralogical analyses of the Illinois Basin refuse samples are in progress. Research has been started on selected refuse samples to reveal the associations and structural relationships among the trace element and mineral components. A series of aqueous leaching experiments, incorporating refuse samples from the Illinois Basin, have been completed and partial results obtained. The purpose of this study is to assess the dependence of trace-element releases during leaching on the mineralogy of the refuse materials. Finally, preliminary results have been obtained from a study of trace-element leachability from an Illinois Basin coal. The experimental variables in this investigation are coal particle size, reaction time, and leachate pH, and temperature and oxygen content.

9643 (ORNL/EIS—94) **Environmental, health, and control aspects of coal conversion: an information overview. Volume 1.** Braunstein, H.M.; Copenhaver, E.D.; Pfuderer, H.A. (eds.). (Oak Ridge National Lab., Tenn. (USA)). Apr 1977. Contract W-7406-ENG-26. 538p. Dep. NTIS, PC A23/MF A01.

Four chapters from this first volume of the report have been entered individually into EDB, ERA and EAPA. They cover: coal, its origin, classification, and physical and chemical properties; coal conversion processes: process effluents (quantities and control technologies); and the analysis of coal and coal products (including wastes). (LTN)

9644 (ORNL/EIS—94, pp 2.1-2.14) **Coal: origin, classification, and physical and chemical properties.** Ensminger, J.T. Apr 1977.

In Environmental, health, and control aspects of coal conversion: an information overview. Volume 1.

Fossilized material from ancient plants, converted by exposure to high temperatures in the earth's crust over long periods of

time, makes up the complex carbonaceous substance known as coal. Coal was formed through a continuous series of alterations: living plants > peat > lignite > subbituminous coal > bituminous coal > anthracite. This process is referred to as metamorphosis; the degree of metamorphosis is called rank. Carbon content increases, and volatile matter decreases, with increase in rank. Coal is composed basically of two types of materials: (1) inorganic, crystalline minerals from surrounding geological formations and (2) macerals, the fragmentary organic remains of plants. An elemental analysis of coal reveals the presence of many trace elements, some of which may be environmentally hazardous. Sulfur in coal occurs in three forms: in organic combination with the coal material, as the minerals pyrite or marcasite, or as inorganic sulfate. No coal is uniform throughout in rank or in content of minerals and macerals. Coals of the same rank from different basins may vary widely because of different environmental influences. The physical characteristics of coal—moisture content and porosity, for example—may significantly affect their suitability for conversion processes. Specific gravity, hardness, strength, friability, grindability, and moisture content are all at least generally related to coal rank. The United States contains about half of the total world reserves of coal.

9645 (ORNL/EIS—94, pp 5.1-5.78) **Analysis of coal and coal products.** Dailey, G.A.; Michelson, D.C. Apr 1977.

In Environmental, health, and control aspects of coal conversion: an information overview. Volume 1.

Spectrophotometric techniques are basic tools for many coal analysis methods. One of the most widely used techniques is atomic absorption spectrometry. Mine and coal dusts in the respirable size range have been examined for trace elements by spark-source mass spectrometry (SSMS). SSMS and thermal emission mass spectrometry (TEMS) have been used for trace element determination in solid coal samples. Sulfur compounds pose special problems in sampling and determination. Several analytical methods in use are described in detail. Polycyclic aromatic hydrocarbon determination and identification methods are based on available pure samples in most cases, with some applications to analysis of air particulate samples. Analytical methods include computerized gas chromatographic-mass spectrometric (GC-MS) systems and liquid chromatography. Benzo[a]pyrene is of special concern as it is a known carcinogen. Quantitative analysis is difficult since it usually occurs in a complex hydrocarbon mixture and is often accompanied by an isomer. Phenols in low-temperature bituminous coal tar distillates have been determined by gas-liquid chromatography. This technique is simpler and more direct than infrared spectrometry. Finally, the development and adaptation of separations methodologies are of prime importance in testing and monitoring coal conversion operations and the products and by-products. (LTN)

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 9534, 9676, 10065

9646 (CONF-7605160—) **Proceedings of the first symposium on management of residuals from synthetic fuels production.** Schmidt-Collerus, J.J.; Bonomo, F.S. (eds.). (Denver Research Inst., Colo. (USA)). 1976. 354p. of Denver.

From 1. symposium on management of residuals from synthetic fuels production; Denver, Colorado, USA (25 May 1976).

Separate entries were prepared for four sections of the report.

9647 (CONF-7605160—, pp 31-54) **Approach to residuals management in coal conversion processing.** Massey, M.J. (Carnegie-Mellon Univ., Pittsburgh). 1976.

From 1. symposium on management of residuals from synthetic fuels production; Denver, Colorado, USA (25 May 1976).

In Proceedings of the first symposium on management of residuals from synthetic fuels production.

The basic characteristics of coal conversion are briefly reviewed; it can be viewed as the hydrogenation of coal. Major and alternative strategies in coal gasification and liquefaction are examined. Characteristics of coal gasification plant effluent production are studied, with data given for a Synthane gasifier, and for Hygas and CO_2-Acceptor gasification of lignite. 19 figs. (DLC)

9648 (ENV/SEM—4/Cb.3) **Test results from a stack gas desulfurization plant using the Hoelter process.** Esche, M. (Saarberg-Hoelter Umwelttechnik G.m.b.H., Saarbruecken (Germany, F.R.)). 1975. 11p. (CONF-751183—1). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 2. seminary of the commission for Europe (United Nations) for the desulfurization of fuel and stack gas; Washington, District of Columbia, USA (11 Nov 1975).

A stack gas desulfurization plant designed to operate on a flow of 125,000 Nm^3/h (circumflex = 40 MW), as produced by a coal-fired power plant of the Saarbergwerke AG, has, in thousands of operating hours, proved the wide-ranging technical applicability of the Hoelter Process. As a result of the special alkaline wash water containing chloride ions, there is no destructive scaling or plugging as is the case with many lime-based wash methods. Stable desulfurization of approximately 95 percent was obtained over a period of many months with low energy consumption and an operating flexibility of 50 to 110 percent full load capacity. Recovery of gypsum wastes of approximately 95 percent $CaSO_4$, with simple depositing and/or further processing was obtained. Specific over-all costs (including capital cost) were found to be under 0.2 cents/kWh.

9649 (EPA—600/9-77-017) **Coal cleaning with scrubbing for sulfur control: an engineering/economic summary.** (Environmental Protection Agency, Washington, D.C. (USA)). Aug 1977. 19p. NTIS.

The purpose of this study is to identify an economic means of keeping higher sulfur content coals in the energy market. Data generated by the Bureau of Mines indicate that some Eastern coals will show a significant reduction in ash and sulfur contents when physically cleaned to a 90% weight yield. With current technology, this level of physical cleaning can often be accomplished at an attractive cost. These coals with reduced ash and sulfur levels are often not too far removed from the sulfur content required to meet environmental standards in the geographic areas historically served by these coals. When coal can be physically cleaned to a sulfur content close to that required to meet governing emission standards, a flue gas desulfurization (FGD) system treating only a portion of the flue gas would permit the coal burning facility to comply with such emission regulations. In many cases, the net cost of physical cleaning followed by FGD is substantially less than that associated with meeting standards exclusively with a larger capacity FGD system. The overall study findings covering new utility plants using physically cleaned coal followed by FGD indicated a savings of 2% to 112% as compared to meeting standards by FGD alone. The results were even more impressive for existing plants, where study assessments indicated a 13% to 140% savings for physical cleaning followed by FGD as compared to FGD alone.

9650 (FE—2549-6) **Development of potential uses for the residue from fluidized bed combustion processes. Quarterly technical progress report.** Minnick, L.J. (Energy Research and Development Administration, Washington, D.C. (USA)). Sep 1977. Contract EF-77-C-01-2549. 23p. Dep. NTIS, PC A02/MF A01.

Supplementing the conclusions submitted previously, it is indicated that the beneficiation of the residue by dry sieving and wet tabling offers a good approach to modifying the FBC residue. Wet tabling is very effective in removing the free lime in relatively pure condition. In addition to crushing or milling which influences the availability of free lime content, a wet blunging step is also a feasible approach to separating this ingredient. Laboratory tests using the residue in structural compositions continue to show unusually good strength values. The design of mixtures for road base applications has indicated that a wide range of compositions are possible for this application. Evaluation of the sludge from the SO/sub x/ scrubber test shows that good stabilization of the scrubber by-product is possible. This should offer advantages for the use of the FBC residue in small industrial type applications where disposal of the sludge could be a serious problem.

9651 (FE—2608-4) **Feasibility study of coal slag based glasses for hot gas clean-up. Fourth monthly progress report, August 1—31, 1977.** (General Electric Co., Philadelphia, Pa. (USA)). 15 Sep 1977. Contract EF-77-C-01-2608. 12p. Dep. NTIS, PC A02/MF A01.

Task 1-Fly Ash Melt Studies are now aimed at elucidating the effect of fly ash additions on the viscosity of the amber container glass. A very interesting and useful effect has been discovered. It was found that 2 percent fly ash markedly reduces the viscosity in a 1-hr at 1000°C test while higher percents of fly ash increase the viscosity at these conditions. Then longer times at temperature reduce these latter effects. It thus appears that the additions of fly ash during operation of this particle entrainment method may actually provide a self-regulating feature and a wide range of operating conditions. Task 2 - Particle Collection Studies. Three runs of the duct at glycerine viscosities of 1, 1.5 and 2 poises (20,7½, and 0°C) showed particle pickup by the glycerine to be at least 99 percent in each case. The duct has been modified to permit recovery of the particles and glycerine from each section. These data are now being reduced. Task 3 - Further work on Task 3 has been initiated including a visit to the GE Lamp Glass Department plant and the initial review of plans for a large scale coal combustor - gas turbine central station plant which would utilize hot gas clean-up.

9652 (FE—2608-5) **Feasibility study of coal slag based glasses for hot gas clean-up. Fifth monthly progress report, 1 September 1977—30 September 1977.** (General Electric Co., Philadelphia, Pa. (USA)). 15 Oct 1977. Contract EF-77-C-01-2608. 24p. Dep. NTIS, PC A02/MF A01.

Fly Ash Melt Studies were continued along the lines initiated in August in which various percent (2 to 75 percent) additions of Montana Rosebud fly ash were made to the amber container glass

and heated to 1000°C and 1100°C for times up to 15 hours. It appears that the stickiness of the mixture may still be useful at 1000°C with as much as 25 percent fly ash in the glass although the mixture is no longer fluid as determined by flow button tests. At 1100°C, additions of 10, 15 and 20 percent fly ash were still quite fluid in even 1 hour tests. It appears therefore that we can safely expect these combinations to be useful to at least 15 percent loadings. In the Particle Collection Studies several further modifications and runs have been made in the clear plastic labyrinth duct using glycerine as a model fluid. All of the 16 runs made to date are summarized. Some highlights of the work are briefly reported.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 9531, 9602, 9642, 9675, 9677, 9678, 10911, 10940

9653 (DP—1455, pp 47-48) **Ash basin reclamation for agricultural use.** Horton, J.H. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

The disposal of coal ashes in the United States has consumed many hectares of land and removed it from production of food and fiber. Although ashes have possible economic value, their use has been very limited, and the territory covered by them continues to grow. Because of the scarcity of arable land in England, reclamation studies were made two decades ago. Those studies showed that some tolerant crops could be grown with a thin soil cover over the fly ash. One large Savannah River Plant ash basin filled with ashes from a stoker-fed boiler has been abandoned since 1964. During 1976, a study was begun to determine whether trees, grasses, or legumes could be grown on these ashes with only the fertilizer applications required on local agricultural soils. Loblolly pine, sweetgum, and sycamore seedlings have been successfully established, and survival and growth was much better on the ashes than on a local agricultural soil. Very unfavorable weather conditions caused a complete failure of grasses and legumes on both soil and ashes.

9654 (NP—22602) **Solids temperature and burn-up curve of burning Rhenish brown coal and its influence on environmental pollution.** Willmes, O. (Stuttgart Univ. (TH) (Germany, F.R.)). 1976. 157p. (In German). Dep. NTIS (US Sales Only), PC A08/MF A01.

Thesis.

To obtain data on the heating surface pollution in combustion chambers of brown coal dust-fired furnaces, theoretical and experimental tests with respect to the burn-up of individual particles have been carried out. A mathematical burn-up model is introduced in order to be able to estimate the temperature curve which can hardly be determined by experiment. For a distribution of equal-sized grains and also for a realistic grain distribution, the particle temperature of brown coal dust is determined as well as the smoke gas temperature and burn-up. The usefulness of the model is tested by means of the results obtained in the experimental chamber. The calculation shows that particles of 90 to 360 μm may have temperatures of up to 1,450°C. Smaller particles, due to their higher loss of heat, hardly exceed the maximum gas temperatures of approximately 1,200°C. Furthermore the reaction of the sulfur contained in brown coal during transport in the combustion chamber is discussed. A formation mechanism for the combustion chamber pollution is described.

9655 (ORNL/EIS—95, pp 6.1-6.131) **Environmental interactions.** Ross, R.H. Apr 1977.

In Environmental, health, and control aspects of coal conversion: an information overview. Volume 2.

A knowledge of the environmental interactions of possible pollutants—hydrocarbons, trace elements, sulfur oxides, and nitrogen oxides—will help to assess the environmental stress introduced by coal conversion plants. The presence of polycyclic aromatic hydrocarbons (PAH) cannot be attributed solely to man's activities; certain bacteria and plants synthesize PAH during normal development, and forest and prairie fires can add significant amounts. PAH entering water systems will undergo decomposition, storage, or removal, with solubility playing an important role in determining which specific interactions prevail. The fate of hydrocarbons in soil is influenced primarily by biodegradation. PAH activity in the air is largely determined by its association with particulate matter and the behavior of the particulates. In aquatic systems, most trace elements are found either in the water column or sediment, with little in the biota; behavior and transport result from specific processes such as association with particulate matter in rivers, flocculation in estuaries, and precipitation in oceans. In soils, trace elements often have long retention times but may undergo chemical or biological changes that increase their mobility. The fate of trace elements in air is determined by dispersion, chemical reaction, and fallout. Anthropogenic sulfur dioxide (SO_2) emissions far exceed natural SO_2 background levels. SO_2 can travel great distances in the atmosphere, but is removed via rainout and washout. In the atmosphere, SO_2 may undergo significant chemical reactions, such as conversion to sulfuric acid. Most global nitrogen oxide (NO/sub x/) emissions originate from natural sources. Chemical reactions are important in evaluating NO/sub x/ as pollutants; hydrocarbon intervention in the nitrogen dioxide photolytic cycle, for example, leads to ozone accumulation and probably peroxyacyl nitrate production.

9656 (ORNL/EIS—95, pp 8.1-8.118) **Plant interactions.** Carrier, R.F. Apr 1977.

In Environmental, health, and control aspects of coal conversion: an information overview. Volume 2.

The interactions of environmental pollutants with vegetation are as complex as they are important. Acute exposure to atmospheric pollutants such as sulfur dioxide, fluorides, ozone, oxides of nitrogen and other oxidants, particulates, hydrochloric acid, ammonia, ethylene, and chlorides and chlorine has caused visible plant injuries such as chlorosis, necrosis, abscission of plant parts, and disturbance of pigment systems. These symptoms have been used as indicators of environmental pollutants and to estimate agricultural damage. The interdependence of a variety of factors ultimately determines the effect of pollutants on vegetation. These factors include environmental influences (relative humidity, temperature, edaphic conditions, climate, light conditions, ambient levels of other pollutants) and characteristics of the plant itself (species, variety, age, disease, nutritional condition). Acid rain, largely the result of sulfur dioxide pollution, may damage plants at distances of up to 1000 km from the pollutant source. In the aquatic ecosystem, pollution by hydrocarbons, heated effluents, trace metals, ammonia, and various inorganic compounds such as sulfates and sulfides has caused effects ranging from growth inhibition to growth stimulation, reproductive alterations, toxic reactions, and changes in species diversity. Trace elements and heavy metals may be taken up and accumulated by both aquatic and terrestrial plants, with or without injury to the plant itself. Humans and livestock have suffered toxic effects from the ingestion of selenium-bearing plants while livestock have incurred molybdenosis and fluorosis from the ingestion of plants containing (or bearing) high concentrations of molybdenum or fluorine. Human exposure to polycyclic aromatic hydrocarbons (PAH) includes those ingested with food plants. Certain plants, particularly the lichens and bryophytes, are used as inexpensive and sensitive indicators of pollutants. (LTN)

9657 **Organic contaminants in aqueous coal conversion effluents: environmental consequences and research priorities.** Herbes, S.E.; Southworth, G.R.; Gehrs, C.W. (Oak Ridge National Lab., TN). pp 295-303 of In Trace substances in environmental health. X. Hemphill, D.D. (ed.). Columbia, MO; Univ. of Missouri (1976).

The anticipated implementation within several decades of an extensive coal conversion industry in the United States will result in production of substantial quantities of highly contaminated wastewater. Many of the contaminants produced, if released into natural waters, could have deleterious effects on aquatic ecosystems and ultimately on human life. Research is required to determine potential acute and sub-acute effects of potentially hazardous effluents constituents and to evaluate their transport and persistence in aquatic systems. To facilitate a rational assignment of future aquatic research priorities to answer these issues, a systematic assessment of the environmental hazards of anticipated organic components of aqueous coal liquefaction effluents by the compilation of a critical literature review has been initiated. Five major classes of organic compounds have been operationally defined: (1) phenols, (2) arylamines (organic bases), (3) aliphatic hydrocarbons, (4) mono- and polycyclic aromatic hydrocarbons (PAH), and (5) sulfur-containing compounds. A summary assessment is presented of each class on the basis of (1) concentrations anticipated in coal liquefaction effluents, (2) removal by wastewater treatment systems, (3) acute toxicity, (4) chronic toxic effects on aquatic organisms, and (5) environmental transport and persistence. Gaps in understanding and future research needs are identified.

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 9644

9658 (NSF/RA—76-0337) **Pennsylvanian coal-bearing strata of the Narragansett Basin.** (Boston Coll., Weston, Mass. (USA). Weston Observatory). 1976. vp. College, MA.

This report describes the progress of the Narragansett Basin Project for the first eleven months. The abstract covers results of the coal exploration, related scientific studies, and other non-geologic studies. Appendix C concentrates on the contributions to the understanding of New England regional geology that have been made this past year. Complete logs of the drill-cores and analyses of the physical and chemical properties of the coal seams are available at Weston Observatory, upon request.

9659 **Determination of low-amplitude formation fracturing in coal fields from geophysical data.** Mikhed'ko, A.F.; Sokolov, V.A. *Razved. Okhr. Nedr;* No. 7, 43-47(1975). (In Russian).

In the eastern Donbas, the USSR, the recurrence of sedimentation cycles and their differing from one another in geoelectric characteristic allow borehole sections to be correlated by logs, and velocity logs in particular. The intervals in dislocated rocks near a fault exhibit lower resistances and positive anomalies on gamma-gamma logs and diagrammes from well calliper measurements as compared to the values of these parameters in a given undisturbed rock. The dislocation amplitude is determined from changes in the normal thickness of the interval between the nearest key horizons (limestones, coal seams) and by analysing the geoelectric section of the cycle concerned. When there is a feebly marked zone of disturbed rocks near the fault, the latter method plays a decisive role in identifying its presence. The methods developed are in practical use in the eastern Donbas. Examples are given of identifying dislocations with an amplitude of 3 m or more.

MINING

REFER ALSO TO CITATION(S) 9602

9660 (BM-IC—8762) **Correlating microfilm mine maps with topographic maps.** Uhrin, D.C. (Bureau of Mines, Washington, D.C. (USA)). 1977. 32p. Dep. NTIS, PC A03/MF A01.

Two improved methods have been developed to transfer microfilmed mine maps to suitable base maps showing surface features. The methods provide for (1) positioning and orienting maps; (2) merging adjacent maps; and (3) plotting maps at a common scale. One method produces an overlay mosaic of mine maps using an integrated camera-processor. This photographic method shows the details of mine workings and is most useful for specific limited-area projects. In the second method, outlines of mine maps are digitized, manipulated, and plotted as overlays using a computer. This computer method can plot mine outlines and spatially index large numbers of microfilmed maps. Microfilmed mine maps used in this Bureau of Mines study are on file in the Mine Map Repository of the Eastern Field Operations Center. The base maps are U.S. Geological Survey 7.5-minute topographic maps. The demonstration area is located in the New Kensington East and West quadrangles, Pennsylvania.

9661 (BM-RI—8252) **Single-entry development for longwall mining. Research approach and results at Sunnyside No. 2 mine, Carbon County, Utah.** Poad, M.E.; Waddell, G.G.; Phillips, E.L. (Bureau of Mines, Washington, D.C. (USA)). 1977. 34p. Dep. NTIS, PC A03/MF A01.

This Bureau of Mines report presents two phases of a research program to evaluate a single-entry system for longwall development. Organizations participating in the program, which began in July 1971, include the Bureau of Mines, the Mining Enforcement and Safety Administration, and the University of Utah, working under a cooperative agreement with Kaiser Steel Corp. at its Sunnyside mine in Utah. Part 1 of this report describes the present longwall mining practice, including a brief history, and discusses the advantages and disadvantages of a single-entry development system and its introduction in the United States. Part 2 of the report presents the research program, test design, instrumentation for ground and support evaluation, and the test results from the No. 2 mine. Subsequent reports will describe the research conducted in the No. 1 mine.

9662 (FE—1231-8) **Design optimization in underground coal systems. Interim report, January—March 1977.** Haycocks, C.; Townsend, J.M.; Neall, G.M.; Johnson, L.P. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Dept. of Mining and Minerals Engineering). Apr 1977. Contract EX-76-C-01-1231. 57p. Dep. NTIS, PC A03/MF A01.

Progress is reported in (1) measuring the mechanical properties of rock and coal specimens with the aim of predicting the load bearing capacity of pillars, supports, etc.; (2) investigating longwall mining, including equipment and computer simulation; and (3) evaluating roof-truss support systems with the aid of photoelastic models stressed experimentally. (LTN)

9663 (TID—22789) **Annual review of selected mining research activities on the Bureau of Mines.** Church, J.C. (comp.). (Bureau of Mines, Washington, D.C. (USA)). Aug 1977. 79p. Dep. NTIS, PC A05/MF A01.

The Bureau's safety R and D program is aimed at providing solutions to problems in all facets of mining. Some of these include fire prevention, suppression, and extinguishment in mines; reduction of explosion hazards through improved personnel safety procedures; degasification and control techniques in high, permeable coalbeds; improved ventilation systems to dilute methane in working areas; roof and rib control to provide inherently safe operating environments; electrical and mechanical improvement relative to safety; underground illumination; emergency communication; refuge chamber installation; emergency hoisting procedures; and techniques for mine sealing following a disaster. Presently the Bureau is engaged in over 200 coal and noncoal safety peojects.

9664 (TID—27669) **Manpower for coal mining: supply, demand, and training.** Friedman, B.S. (Energy Research and Development Administration, Washington, D.C. (USA)). Sep 1977. 84p. Dep. NTIS, PC A05/MF A01.

This report assesses current and potential demand for coal-mining manpower and reviews the training and retraining programs designed to produce the work force required as the nation turns more and more to coal in order to lessen its dependence on foreign coal. A similar assessment is made regarding professional staff, particularly mining and coal preparation engineers. The industry has demonstrated capacity to recruit and train—or start training—coal mine employees apparently ample for its expanding needs. Barring precipitous drops in productivity, and barring wars, embargoes, and significant declines in unemployment—the coal industry is not expected to suffer a nation-wide manpower shortage in the next decade. Local and regional shortages of skilled workers and supervisors may occur, however; but these can probably be avoided. Shortage or no shortage, there is as always the need to improve the technical proficiency and safety-consciousness of the current work force as well as the new hires—particularly so since mining has become heavily mechanized. Recruiting efforts should be selective, i.e., emphasizing calibre and potential—and launched only when and where job opportunities can be identified. Currently, coal mining and coal preparation engineers are in short supply. Several recommendations are presented. (LTN)

9665 **Mining apparatus.** Peake, C.V. US Patent 4,045,087. 30 Aug 1977. Priority date 7 Sep 1974, United Kingdom of Great Britain and Northern Ireland (UK). 4p.

Mining apparatus for longwall mining is described comprising a mineral winning machine which traverses a mineral face, a row of self-advanceable roof supports parallel to the face, and a conveyor also parallel to the face for removing cut mineral, the supports having platforms which support the conveyor, the hydraulic props of the supports being positioned between the mineral face and the conveyor. The winning machine thereby can cut substantially across its whole depth, the props being adjacent the face to be cut. Ramps are provided on the supports and the conveyor to scoop out mineral onto the platforms and then on the conveyor, during advance of the supports and the conveyor.

9666 **Permeability from single and multiple detonations in boreholes.** McKee, C.R. (Univ. of Wyoming, Laramie); Hanson, M.E.; Terhune, R.W. *In Situ;* **1**: No. 1, 37-73(1977).

Relationships describing the permeability enhancement caused by explosive detonations in boreholes have been derived and combined to yield an equation for the case in which the stress decays asymptotically as a power law. This relationship has been compared with available measurements from the American Hardhat nuclear shot, the French nuclear events in Hoggar granite, and a chemical explosive shot in coal near Kemmerer, Wyoming. Significant correlation between theory and experimental measurements is observed. A comparison between single and multiple detonations shows that permeability enhancement falls off steeply near the shot. However, enhancement can be considerable midway between two shots spaced 10 cavity radii apart. The degree to which enhancement can be significant depends on material properties and initial fracture density. Porosity distribution from the explosive is the dominant parameter in permeability enhancement.

9667 **Uluchshenie uslovii i povyshenie bezopasnosti truda na shakhtakh. (Improvement of conditions and increase of the work safety in mines).** Lindenau, N.I. Moscow; Nedra (1976). 176p.

Methods to estimate optimum parameters of excavation plots and fields for different systems of exploitation were studied. Recommendations are given with respect to the behavior of degasification operations in gassing mines. The ultrasonic method of injecting water into strata was described. The main technical demands of preventing and quenching fires from spontaneous combustion of coal were tested. 51 figures, 44 tables.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 9535, 9540, 9642, 10600, 10739

9668 **Method for extrusion of coal containing body.** Furman, A.H. (to General Electric Co.). US Patent 4,049,390. 20 Sep 1977. Filed date 2 Aug 1976. 10p.

Improved extrusion apparatus is shown for the preparation of a rod-like body from a coal-containing particulate mixture. Control mechanisms are disclosed for automatically controlling the throughput resistance experienced by the rod-like (or a developing version thereof) body through a die. Portions of the die wall near the outlet

end thereof are adapted for inward displacement in response to these control mechanisms. This embodiment may also be coupled with a longitudinally movable die and control means for adjusting the length of the consolidating coal-containing mixture in contact with surface of the movable die.

9669 (BM-RI—8238) **Generalized distribution curve for characterizing the performance of coal-cleaning equipment.** Gottfried, B.S.; Jacobsen, P.S. (Bureau of Mines, Washington, D.C. (USA)). 1977. 25p. Dep. NTIS, PC A02/MF A01.

This Bureau of Mines report presents a method for combining the distribution curves at different specific gravities of separation, for a given piece of coal-cleaning equipment and a given raw coal feed, into a single, generalized distribution curve normalized with respect to specific gravity and, therefore, independent of the specific gravity of separation. Illustrative generalized distribution curves, based upon Bureau of Mines collected data on industrial operations, are presented for five different types of coal-cleaning equipment. The well-known concept of probable error is extended to the generalized distribution curve. It is shown that the conventional probable error is directly proportional to the specific gravity of separation. A number of sample calculations, illustrating the use of the generalized distribution curve and generalized probable error, are presented.

9670 (FE—2475-12) **Developing/modifying coal grinding procedures and equipment to produce predictable size distributions during coal preparation. Monthly progress report, August 1977.** Luckie, P.T. (Kennedy Van Saun Corp., Danville, Pa. (USA)). 10 Sep 1977. Contract EX-76-C-01-2475. 60p. Dep. NTIS, PC A04/MF A01.

A summary of analyses on the Ohio No. 9 coal sample was prepared since it is the potential feedstock to the CONOCO gasification project. Initial results on the mechanical properties of the coals were also obtained. The hammer mill grinding system and the ball and race mill grinding system have been installed. Testing of various coal samples has been underway in the air swept ball mill grinding system. Modifications to the wet ball mill were delayed while an emergency repair of the sample preparation crusher was made. The data obtained during testing have been summarized and presented in a simple form.

9671 **Apparatus and process for the drying of wet, loose material, in particular, coke power or fines.** Unger, G. US Patent 4,043,745. 23 Aug 1977. Priority date 25 Sep 1975, German, Federal Republic of (F.R. Germany). 8p.

A process and apparatus are described for the drying of coke fines without the generation of noxious quantities of dust by means of a burner flame and associated flue gases extending along an axis. The wet loose material is moved along the axis toward the burner and rotated to expose it to the flue gases for predrying the material. The major quantity of moisture is removed during the predrying and entrained in the discharged flue gases. The moisture level of the predried material is maintained sufficiently high to prevent dust generation. Thereafter, the movement and rotation of the predried material is continued in an enclosed space heated by the flame and gases, to complete the drying of the material with little or no dust generation.

COMBUSTION

REFER ALSO TO CITATION(S) 9596, 9650, 9654, 10060, 10066, 10656

9672 (FE—2451-3) **Gas-solids interactions in the distribution zone of a fluidized bed. Phase I. Special interim report: literature search.** Kirwan, D.J.; Vines, S. (Virginia Univ., Charlottesville (USA)). Oct 1977. Contract EX-76-S-01-2451. 26p. Dep. NTIS, PC A03/MF A01.

Based on a literature search of several abstract journals, a number of conclusions can be drawn about the importance of the gas distribution zone and the effect of distribution on overall fluidized bed performance. The quality of gas distribution has a well documented effect on the physical and chemical parameters of a fluidized bed. The design of gas distributors for fluidized beds is largely empirical. Mass and momentum transfer characteristics of a gas jet in a fluidized bed have been reported. Data on gas-solids movement in the immediate region of gas jet entry are limited to selected determinations of stagnant (nonmoving) zones. More work is needed to delineate the separate zones of nonmoving solids, moving but nonfluidized solids, emulsion phase fluidized solids, bubble phase fluidized solids and gas jet in the vicinity of a gas jet entry to a fluidized bed.

9673 (FE—2516-3) **Centrifugal fluidized combustion of coal. Quarterly report, April—June 1977.** Levy, E.K.; Chen, J.C. (Lehigh Univ., Bethlehem, Pa. (USA)). Jul 1977. Contract EX-76-S-01-2516. 14p. Dep. NTIS, PC A02/MF A01.

Most of the activity dealt with the design and fabrication of equipment. The new test section for batch experiments was completed and installed and some data on minimum fluidization and bed pressure drop were obtained. The experimental results continue to be in good agreement with the theoretical model. The design of the test sections for solids feed and removal was completed and fabrication was begun; and the probes for measuring air velocities and air flow rates were calibrated.

9674 (FE—2579-11) **Granular bed filter development program. Monthly report for August 1977.** Phillips, K.E. (Combustion Power Co., Inc., Menlo Park, Calif. (USA)). Oct 1977. Contract EF-77-C-01-2579. 25p. Dep. NTIS, PC A02/MF A01.

This is an intensive program to determine the scientific principles upon which granular-bed filtration operates and to design and construct a Granular-Bed Filter (GBF) device which can be subjected to controlled cold-flow testing for verification of these principles. The objective is to generate the desired information on the cold-flow model for future application, correlation, performance prediction, and implementation on a second generation GBF hot-flow model. The scope of the cold-flow program incorporates; theoretical analysis, in which the theories and mechanisms of the interaction of exhaust gases and granular media are studied and commuted to mathematical expressions for computer simulation; design and construction of the cold-flow model for parametric testing and correlation with the math model; installation of a particle injection and sampling facility to enable controlled dust injection, particle sampling and analysis, and filter performance determination; and evaluation of filter screen deposition phenomena and the effectiveness of various deposit-removing devices. The report describes the changes introduced in the mathematical model as a result of revised filtration coefficients developed by Professor Goren from recent experimental work; further work performed in the computer code to incorporate three size classes of particulate and also to improve the speed of execution; the completion of the first phase of testing which included a series of subexperiments to evaluate the effects of various particulate sizes and media flow variations on filter efficiency; the incorporation of the large diameter screen and subsequent thick bed testing to date.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 9548, 9572, 10657

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 9661, 9664

9675 (ORNL/EIS—95) **Environmental, health, and control aspects of coal conversion: an information overview. Volume 2.** Braunstein, H.M.; Copenhaver, E.D.; Pfuderer, H.A. (Oak Ridge National Lab., Tenn. (USA)). Apr 1977. Contract W-7405-ENG-26. 297p. Dep. NTIS, PC A99/MF A01.

Five chapters from this second volume have been entered individually into EDB, ERA and EAPA. They deal with the environmental behavior of possible pollutants (polycyclic aromatic hydrocarbons, sulfur dioxide, nitrogen oxides, trace elements, etc.) from coal conversion plants and the possible biological effects of these pollutants on microbes, plants, animals and man (including occupational diseases). The results presented are very detailed, but made reasonably accessible by the incorporation of appendices giving IUPAC names and structural formulae of common polycyclic aromatic hydrocarbons and a chemical index. (LTN)

9676 (ORNL/EIS—95, pp 7.1-7.107) **Microbial interactions.** Dailey, G.A. Apr 1977.

In Environmental, health, and control aspects of coal conversion: an information overview. Volume 2.

Microorganisms are important ecologically in the degradation of most coal conversion wastes. Activated sludge has been shown to be an effective utilizer of pollutants confined to waste streams from coal conversion processes, while common soil and water bacteria have exhibited a similar utilization of pollutants escaping to the environment. Organic wastes are readily degraded by microbes. Phenols and ammonia are two common pollutants found in the waste streams, which are primarily biotreated by activated sludge systems. Phenol, the major waste discharge toxicant, is degraded readily to resorcinol and pyrocatechol by bacteria of the Pseudomonas genus. Vigorous aeration during waste treatment is required. Polycyclic aromatic hydrocarbons (PAH), another coal conversion waste, have been found to be degraded by common soil bacteria. Pyridine compounds, released into the environment by the industrial and domestic use of coal, are degraded by actinomycetes soil bacteria. Microbial metabolism of simple pyridine compounds produces dihydroxypyridine compounds. Elements released into the environment

by coal conversion processes are commonly transformed by microorganisms. Thiobacillus species are able to remove up to 90% of pyritic iron and sulfur in coal during simple storage. These bacteria also oxidize ferrous iron, thiosulfate, and sulfur. Sulfur bacteria are also important parts of the sulfur cycle and perform both assimilatory and dissimilatory sulfate reduction. Trace metals released during coal conversion are transformed by microorganisms and can lead to an overall metal content rise in the microbial biomass. Lead and mercury are biomethylated, forming the more toxic and volatile dimethylmercury and tetramethyl lead.

9677 (ORNL/EIS—95, pp 9.1-9.163) **Animals: bioenvironmental effects.** Wilkes, D.J. Apr 1977.

In Environmental, health, and control aspects of coal conversion: an information overview. Volume 2.

Many organic compounds may be released into the environment from coal conversion processes. Polycyclic aromatic hydrocarbons and heterocyclic compounds have been identified as of particular environmental concern because of their carcinogenic potential. Organisms may accumulate PAH and heterocyclics from air by elution in the lungs from inhaled particles to which the compounds may be sorbed, from aquatic environments where both soluble and particulate forms are available for absorption through surface or gill membranes, or from ingestion of particulates or food contaminated with the compounds. Storage in tissues of high lipid content—primarily liver, gall bladder, and hepatopancreas—is favored. Rates and extent of metabolism are species dependent. While detoxification mechanisms vary widely among species, some transformation products may be more toxic than the parent compound. Many trace elements have been identified as constituents of coal and may be released into the environment through conversion processes. Potential toxicity and bioaccumulation of elements is a function of concentration, chemical form, environmental chemistry, and food web dynamics. Although many elements are involved in natural biochemical processes that regulate accumulation under normal conditions, some elements—notably cadmium, mercury, and lead—are cumulative poisons. Such metals may exert potent neurotoxic and nephrotoxic effects. Some metal compounds, such as nickel carbonyl, may be highly carcinogenic. Many elements may be acutely toxic at relatively low environmental concentrations, with chronic effects being evoked at concentrations as low as in the part-per-hundred-million range. Furthermore, other environmental factors may affect the toxic action of trace elements on biota.

9678 (ORNL/EIS—95, pp 10.1-10.99) **Humans: metabolism and biological effects.** Talmage, S.S. Apr 1977.

In Environmental, health, and control aspects of coal conversion: an information overview. Volume 2.

Coal conversion processes may produce and release substances that can be hazardous to human health; some substances are potential carcinogens, cocarcinogens, mutagens, or teratogens. Others promote chronic respiratory and/or metabolic diseases. However, rigorous quantitative data relating human exposure with health effects are still sparse. From the standpoint of human health, the most critical hazard probably confronts industrial workers exposed to high levels of potentially carcinogenic polycyclic aromatic hydrocarbons (PAH). PAH can be taken into the body by inhalation, skin contact, or ingestion. Regardless of the route of entry, the hepatobiliary system and the gastrointestinal tract are the main routes of elimination of both PAH and their metabolites. The metabolites of several PAH have been found to be more mutagenic, carcinogenic, and teratogenic than the parent compounds. Epidemiologic studies of workers in coal gas, coking, and coal hydrogenation industries routinely exposed to the products of coal combustion or distillation show that they run an increased risk of lung, skin, and other cancers. The effect of carcinogens can be enhanced or inhibited by associated substances. For example, particulates, sulfur dioxide, and some aliphatic hydrocarbons have been identified as possible cocarcinogens, whereas vitamin A and several antioxidants appear to give partial protection against the formation of cancers. Potential releases of trace elements during coal conversion processes may produce metabolic disorders. Trace elements of particular importance are lead, mercury, arsenic, vanadium, selenium, nickel, and possibly cadmium and fluoride. Low-level excesses of these elements can have a deleterious effect on human health. Arsenic, beryllium, cadmium, chromate salts, and nickel are known or suspected carcinogens.

REGULATIONS

9679 (TID—27825) **Report on improving coal production by regulatory integration. Phase I. Collection of coal mining permits for Pennsylvania, West Virginia, and Colorado.** (Green International, Inc., Morgantown, W.Va. (USA)). Oct 1976. 114p. Dep. NTIS, PC A06/MF A01.

In addition to collecting and cataloguing coal mining permit-related documents and soliciting comments from applicants and reviewing agencies, five related subjects are described: A more precise and useful definition of "permit"; explicit and precise hypotheses related to the coal permit and regulatory process which may warrant additional investigation; the identification of the need for a comprehensive model of coal production and related industries which incorporates the effects of time (delays or lags) on production levels and prices; the development of possible approaches for increasing the "efficiency" of the permit/regulatory process; and an analysis of the various agencies which might play a role in any future efforts to increase permit/regulatory efficiency. There is a definite need to eliminate (or control) the existing duplication of permit documents and other requirements by state and federal agencies as well as, in some cases, local agencies. Prior to many of the clean stream laws and other environmental controls, the number of required permits for the mining of coal generally numbered less than 10; however, since the inception of the Clean Streams Act, the number has steadily increased and so have the number of agencies local, state and federal. It was found that the number of permits required for the opening or expansion of a coal operation in Pennsylvania was at least 52 and in some instances this number reached 100 or more.

9680 (TID—27825/1) **Catalog of application, permits, and related material pertaining to the permit requirements of the coal industry in Pennsylvania. Supplement A.** (Green International, Inc., Morgantown, W.Va. (USA)). Oct 1976. 578p. Dep. NTIS, PC A25/MF A01.

The various forms which must be filled out to get all the permits necessary to mine coal in Pennsylvania are catalogued. Included also are various Federal forms from the Department of the Interior, Mining Safety and Enforcement, Bureau of Land Management (Regulations), Department of the Army (permits for activities in waterways) and from the Environmental Protection Agency. (LTN)

9681 (TID—27825/2) **Catalog of application, permits, and related material pertaining to the permit requirements of the coal industry in West Virginia. Supplement B.** (Green International, Inc., Morgantown, W.Va. (USA)). Oct 1976. 460p. Dep. NTIS, PC A20/MF A01.

A catalog of application forms (both state and federal), permits and related material pertaining to the permit requirements of the coal industry in West Virginia has been assembled. (LTN)

9682 (TID—27825/3) **Catalog of application, permits, and related material pertaining to the permit requirements of the coal industry in Colorado. Supplement C.** (Green International, Inc., Morgantown, W.Va. (USA)). Oct 1976. 551p. Dep. NTIS, PC A24/MF A01.

A catalog of application forms, permits (both state and federal) and related material pertaining to the permit requirements of the coal industry in Colorado has been assembled. (LTN)

PETROLEUM

GEOLOGY AND EXPLORATION

9683 (SAND—77-1351) **Outer continental shelf program. Second quarterly report, April 1—July 31, 1977.** Reece, E.W. (ed.). (Sandia Labs., Albuquerque, N.Mex. (USA)). Aug 1977. Contract EY-76-C-04-0789. 23p. Dep. NTIS, PC A02/MF A01.

Activities in a project directed to the development of a long-life, self-contained ocean bottom instrumentation and seismic measurement system are reported. An experimental sediment instrumentation system incorporating a high data rate acoustic telemetry system was fabricated and tested in both fresh water and the Gulf of Mexico during the report period. Data were transmitted acoustically rates of up to 2400 bits per second in water up to 600 feet deep with errors of less than one bit error per one thousand bits transmitted. In addition, a limited number of sensors were tested and the detection, acquisition, processing, storage, and retrieval of seismically induced acceleration data were demonstrated. A Sandia designed 3-axis accelerometer package was installed during a general installation-modification period in mid-July. Underwater tests of the deployment of a marine sediment penetrometer (MSP) data transmission cable were conducted at Lake Mead, Nevada, dring April. The new technique involves the use of a high-melting-temperature wax as the encapsulating material and the use of a new high strength cable with a braided kevlar jacket. A parametric study was conducted in the soft saturated sediments of the Great Salt Lake Desert during the week of July 31. Test data have not yet been analyzed.

9684 **Study of carbonate reservoirs from complex of laterolog, microlog method of "two flushing fluids" and normalized curves of laterolog and neutron-gamma logging.** Sokolova, R.A. pp 130-141 of In Kompleksnoe izuchenie geologicheskogo stroeniya karbonat-

nykh kollektorov neftyanykh mestorozhdenij permskoj oblasti. Perm'; Permskoe knizhnoe izdatel'stvo (1975). (In Russian)

Localization of carbonate reservoirs and the determination of their type according to the character of the intrusion of a clay solution filtrate into the layer by means of laterolog and microlaterolog with "two solutions" are discussed. In order to get the effective thickness of the productive carbonate deposits it is profitable to use the method of "two solutions" and the method of normalization of laterolog and neutron-gamma log curves.

9685 Some problems of evaluation of influence of perforation on casing string from well measurement results. Semenova, T.M.; Bernshtein, D.A.; Laptev, N.V. pp no.4 p.159-168 of In Oil exploration geophysics. Moscow; IGIRGI (1974). (In Russian)

The mechanical influences on the casing are studied with instruments based on the registration of scattered γ-radiation : the γ-defectometer-thickness gauge SGDT-2 and the γ-thickness gauge. The combined measurements with both apparatuses before and after the performation allow to determine the degree of deformation and the destructions of the casing under the action of the perforation by measuring the mean thickness of the tube wall along the perimeter of the tube and its inner diameter.

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 10782

9686 (BERC/TPR—77/7) North Stanley Polymer Demonstration Project, second annual report. Johnson, J.P.; Cunningham, J.W.; DuBois, B.M. (Kewanee Oil Co., Tulsa, Okla. (USA)). Oct 1977. Contract EY-76-C-02-0029. 128p. Dep. NTIS, PC A07/MF A01.

This project is a cooperative test of the economics of polymer enhanced waterflooding and is a field scale test involving 1,010 productive acres containing 72 million barrels of pore volume, 19 injection wells, and 28 producers. The primary activity during the second year was successful injection of the polymer slug. Polymer injection was completed June 22, 1977, after injecting 1,194,770 pounds of Dow Pusher 700 and 11,962,918 barrels of water over a period of 372 days. The average polymer concentration was 285 ppM. Nine of the injection wells were given Channelblock (TM) treatments. One well, Pappin 12, did not respond to the Channelblock treatment; it was the closest well to the injection plant, and the pressure was too high for the soft gel to hold. The rate on Pappin 12 was then restricted by use of a flow regulator coil; the polymer (250 ppM) underwent 12% shear degradation passing through the regulator coil. Movement of the slug through the reservoir was monitored by analysis of produced water samples. The producing wells were sampled every two weeks from Feb. through June and once a month thereafter. The water samples were analyzed for salinity and polymer. The primary producing problem was a change in the producing well fluid levels resulting from the changes in injection distribution, and it was necessary to either change out the pump or lower the present pump which resulted in less efficiency. The oil production started responding in Sept. 1976 by increasing 15 BPD to 581 BPD. It increased to 586 BPD in Oct., 590 BPD in Nov., and 592 BPD in Dec. In Jan., production jumped to 660 BPD. It fell back to 641 in Feb. but slowly increased to 658 BPD by May. June's production fell back to 645 BPD, partially as a result of lower injection rates experienced when polymer injection was terminated. (DLC)

PROCESSING

9687 Fractionation process. Jo, H.K. (to UOP Inc.). US Patent 4,053,392. 11 Oct 1977. Filed date 12 Aug 1976. 8p.

A process for fractionating hydrocarbons wherein the overhead vapors of two fractionation columns are admixed and then condensed in a single overhead condenser is described. The overhead liquid is divided into two portions, one of which is used to supply reflux to the column receiving the process feed stream and the other as feed to the second column. Also disclosed is a control system for use on the process. 3 claims, 1 figure.

9688 Manufacture of catalytic cracking charge stocks by hydrocracking. Kelley, A.E.; Reeg, C.P.; Wood, F.C.; Cheadle, G.D. (to Union Oil Co. of California). US Patent 4,040,944. 9 Aug 1977. Filed date 22 Feb 1973. 12p.

A desirably upgraded charge stock for catalytic cracking containing a relatively large proportion of heavy hydrocarbons boiling above about 800°F, is produced by first subjecting a raw feedstock boiling predominantly above 600°F and containing a substantial proportion of material boiling above 800°F to catalytic hydrofining followed by catalytic hydrocracking at high pressures in the presence of a Group VIB and/or Group VIII metal-promoted, crystalline zeolite hydrocracking catalyst. The hydrocracking catalyst and conditions are chosen so as to achieve selective conversion of material boiling between about 600 and 800°F to lower boiling materials with a relatively minor conversion of the 800°F+ material. The resulting product boiling above 400°F is rich in 800°F+ material, and constitutes an excellent catalytic cracking charge stock.

9689 Method of treating hydrocarbon oils. Black, J.C.; Chappell, M.L. (to Union Oil Co. of California). US Patent 2,091,624. 31 Aug 1937. Filed date 24 Apr 1933. vp.

In the process of refining petroleum oil containing paraffin wax the oil is mixed with liquefied hydrocarbon gases having a vapor pressure greater than atmospheric at ordinary atmospheric temperature. The mixture is cooled to a temperature sufficient to congeal the wax content, and the cooled mixture is treated with sulphuric acid. The cooled acid treated mixture is passed through a settling tank to thereby separate acid reaction products and high melting wax from the oil mixture by settling, and the oil mixture is passed from the settling tank to separating the remaining portion of the wax from the oil mixture.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 9677

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 10602

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 9539

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 10911, 11033

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 10602

STORAGE

REFER ALSO TO CITATION(S) 10600

NATURAL GAS

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 9683

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 9715

PRODUCTS AND BY-PRODUCTS

9690 Gastech 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976). 226p. (CONF-7509192—).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

Twenty-one papers are included on energy policy, LNG transport, carrier ships, codes and regulations, design, storage, LNG plants, instrumentation, transfer equipment, leak detectors, boilers, and pipe welding. A panel discussion of gas ship operators on operational problems and the gas transport business is also included. Separate abstracts were prepared for all the papers. (DLC)

9691 Up-dated report on the Prico (TM) process for LNG plants. Stebbing, R.; Pritchard, J.F.; O'Brien, J. pp 151-159 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

Process descriptions are given for both peakshaving and base load LNG plants. The refrigerant compressor is discussed. (DLC)

9692 Measurement of density in custody transfer systems. Blanchard, R.L. (Foxboro/Trans-Sonics Inc., Burlington, MA). pp 161-169 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

The measurement of LNG cargo density in the ship tanks is important as well as that of cargo level. Three techniques for the measurement of density are described and compared: (1) temperature and composition, (2) Archimedes force, and (3) dielectric constant and composition. The Foxboro/Trans-Sonics sensors using these techniques are described. 5 figs. (DLC)

9693 Cargo instrumentation and control system for a floating LPG terminal. Noeltner, R.H. (Simmonds Precision, Vergennes, VT). pp 171-179 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

The barge will be placed into operation in the Java Sea off the coast of Djkarta, Indonesia by mid 1976; it will extract gas from a platform in the Ardjunda fields, liquefy it, store it at -50°F, and off load it to contrast LPG carriers. The instrumentation and control system will provide a complete, integral, automatic system for custody transfer operations. A printout of the total mass of LPG transferred will be available immediately after completion of delivery regardless of ship attitude or liquid composition. (DLC)

9694 Transfer equipment for low-temperature liquid media. Hauk, P.V.; Knappik, H.; Miller, H. (Mannesmannroehren-Werke AG, Dusseldorf). pp 181-182 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

A transfer unit was developed for the transfer of low temperature liquids, such as ethylene and LNG. Its construction and operation are described briefly, including the swivel joints. (DLC)

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 9707

9695 Cargo leak detection systems for cryogenic tankers. Leclerq, J.; Baker, H. pp 185-191 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

Although there are several methods for monitoring the buildup of combustible vapors, two techniques have proved their merit in leak detection on LNG-LPG tankers: nondispersive infrared absorption and catalytic combustion. Multi-point scanning units extend the usefulness of the analyzers. Alarm logic for buildup monitoring and faultfinding can present the information in an acceptable manner. 23 figs.

MARKETING AND ECONOMICS

9696 Role of LNG in French energy policy. Legrand, M. pp 1-2 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

The decision to reduce the French dependence on oil imports will lead to an increasing reliance on natural gas. In 1974, the share of natural gas in energy consumption was 172 billion thermies (10% of the total energy); in 1975, the goal is 370 billion thermies (15.4%). The penetration rates of natural gas in the consumption and industrial sectors are discussed. Purchases of gas aboard are discussed; groups were formed for joint purchases in Iran, Algeria and elsewhere. Liquefaction techniques should ease the problem of transport. (DLC)

9697 EEC view of the development of the gas industry within the Community. Bishop, J.M.C. (Commission of the European Communities, Brussels). pp 5-10 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

The energy policy of the Community is to secure adequate and dependable supplies of energy at an economically supportable cost. Advantages and problems of imports of natural gas are outlined. The objective is the expansion of the gas market to the point where it will account for up to 23% of primary energy by 1985. (A discussion is included at the end of the paper, covering such topics as consumer-producer relations, the market, etc.) (DLC)

9698 Japan's energy needs in the LNG context. Tsumura, A. (Japan Petroleum Development Corp., Tokyo). pp 13-14 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

Projects currently underway or proposed for importing LNG to Japan are described. The Ministry for International Trade and Industry has forecast 710 million M^3 of oil equivalent as the total energy requirement in 1985; 4.2 million tons LNG a year is the target for that year, to fulfill 7.9% of this energy requirement. Pricing considerations are discussed briefly. Japanese experience in the LNG business is also described briefly. A short panel discussion is included. (DLC)

9699 Gas importation projects: an overview of current and probable future developments. Faridany, E.K. (Ocean Phoenix Transport Inc., London). pp 17-26 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

This paper considers base-load LNG movements in international trade in the period until the late 1980s. The forecasts are made with reference to the consuming areas and the related gas supply/demand, price, and legal factors. It is expected that LNG movements will grow annually at least 12% from 15.6 billion m^3/y to 88 or 161 billion m^3/y by 1985. The need for lowering the cost of marine transportation is pointed out. (DLC)

ENVIRONMENTAL EFFECTS

REFER ALSO TO CITATION(S) 10911

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 10897

9700 (MERC/SP—77/4) **Field and laboratory procedures for oriented core analysis of Devonian shales.** Byrer, C.W.; Komar, C.A. (Energy Research and Development Administration, Morgantown, W.Va. (USA). Morgantown Energy Research Center). Aug 1977. 30p. Dep. NTIS, PC A03/MF A01.

Field and laboratory procedures for handling, performing a lithologic description, marking azimuth directions, mapping the native fractures, and measuring directional physical properties of oriented cores are described. In the fulfillment thereof, directional properties of tensile strength, and sonic velocity are correlated with preferred planes of weakness and orientation of visible fractures in the core to ascertain the preferred direction of fracture orientation that should occur in the hydraulic fracturing process. Characterization of the lithology is required to identify intervals for stimulation. Measurements of hardness are conducted to identify containment barriers to fracture growth vertically. All information is required to assist in the design and the development of a pattern of fractured wells for commercialization. Definition and description of the activities required to extract and characterize the oriented cores should serve as the standard methodology for all Devonian Shale core analysis.

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 10773

9701 Contract of LNG transport: the legal analysis. Mankabady, S. (Liverpool Polytechnic). pp 29-32 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

Some of the characteristics of the LNG contracts of transport are described and distinguished from these for LPG (liquefied petroleum gas). Terms of time-charter parties are examined. Legal aspects are examined in detail. (DLC)

9702 LNG tanker terotechnology as applied to design, maintenance, and operation; points on practical conclusions. Soesan, J.M. pp 35-41 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

"Terotechnology" is the management of physical assets over their life cycle in capital-intensive industries (an alternative term is "logistic engineering"). The application of terotechnology to LNG tankers and ship maintenance is discussed. Repair costs are considered. The importance of feedback of information is pointed out. (DLC)

9703 Market for LNG carriers. Gilles, A. (Gaz-Transport, Paris). pp 43-45 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

At the end of April 1975, the world LNG carrier fleet (in service and on order) totalled 67 ships, the distribution of which is given. The ships are separated into the time periods 1960 to 1968 and 1968 to 1975. The roles of French, U.S., and other shipyards in the ship construction are discussed. Negotiations, competition in the shipbuilding industry, etc. are covered. (DLC)

9704 Developments of the Technigaz integrated tank system for methane carriers. Chauvin, J.M. (Technigaz S.A., Paris). pp 47-50 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

The Technigaz system is a new insulation support system for the stainless steel membrane containment design. The insulation is based on PVC foam. Results of testing and of ship performance are discussed. A panel discussion is included. (DLC)

9705 Optimum methods of operation for LNG carriers examining the major containment systems designs. Vrancken, P.L.; Gordon, D. (Conch Methane Services Ltd., London). pp 53-62 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

This paper considers the use of boil-off as fuel for the ship on both the loaded and ballast voyages. Objective is to determine the most advantageous use of boil-off in the operation of 125,000-M^3 ships fitted with self-supporting prismatic (Conch), spherical, and membrane designs, and to assess their relative merits over four representative trade routes. Results show that each of the designs is capable of returning comparable earnings provided each is operated in the most efficient mode. (DLC)

9706 IMCO code for gas tankers: a review of the finalized code. Lakey, R.J. (Inter-governmental Maritime Consultative Organisation, London). pp 65-69 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

In Nov. 1975, the Inter-governmental Maritime Consultative Organization is expected to adopt the Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk. Several chapters of the code are examined. A table of contents of the code is included. Products covered are also listed. (DLC)

9707 Safety of gas carriers with particular reference to the I.C.S. tanker safety guide (liquefied gas): movement control and personnel training. Smith, J.M.S. (International Chamber of Shipping, London); Mathew, R.C.; Crook, J.A.F. pp 71-81 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

Sources of hazards in LNG/LPG marine transport are outlined. A general philosophy of safety is discussed and applied. Design safety, ship-to-shore coordinated control, operational safety, training, manuals, safety guides, traffic control, and port regulations are covered. A panel discussion is included, covering hull damage in a collision and other topics. (DLC)

9708 New regulations for liquefied gas carriers. Henn, A.E.; Dickey, T.R. (United States Coast Guard, Washington, DC). pp 83-91 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

The Coast Guard has been actively involved in developing standards for the safe transportation of liquefied gases for several decades. As a result, the benefits of having an international standard for the design, construction and operation of liquefied gas ships were recognized. The international standard (IMCO) is being used as guidance for revising the U.S. national regulations. In doing so, the Coast Guard provides for the safe containment and transportation of liquefied gases in U.S. ports.

9709 Bureau veritas and gas carriers. pp 105-135 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

The following are given for the design of gas carrier ships: rules and future developments, structural analysis and design principles, and free and forced vibrations. (DLC)

9710 Developments in dual-fired steam-raising plant for LNG carriers. Hillis, R. (Foster Wheeler Power Products Ltd., London). pp 193-205 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

The boilers are capable of burning any gas which evaporated from the cargo tanks as well as heavy fuel oil. The Foster Wheeler ESD (external superheater "D" type) type boiler was proven over 10 years of service experience. Spray and drum desuperheater attemperation, developments for larger LNG carriers, combustion equipment, fuel handling system, boiler controls, and burner management are discussed. 8 figs. (DLC)

9711 Submerged-arc welded 9% Ni steel large diameter pipe for LNG transportation. Maruoka, H.; Nara, Y.; Koizumi, I.; Mizohata, K.; Iwata, A.; Okazawa, T. (Sumitomo Metal Industries Ltd., Tokyo). pp 207-216 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

Welding materials for welding 9% Ni steel by submerged arc welding process were investigated. 70% Ni-15% Cr-3% Ti, 25% Cr-20% Ni and 55% Ni-15% Cr-15% Mo-3% W wires were tested. ZrO_2-SiO: base flux and oxygen-free flux were used. Welded metal cracking tests, mechanical property tests, low temperature destructive tests and thermal expansion tests were conducted. Results were: (1) Using Hastelloy C wire which contains molybdenum and tungsten, low crack susceptibility of welded metal was achieved. (2) The combination ZrO_2-SiO_2 base flux and Hastelloy C wire produced a welded joint of satisfactory tensile strength and high energy absorption at -196°C. The welded joints showed the same destructive strength at low temperature as joints manually welded by Inconel-type covered electrode. (3) Coefficients of thermal expansion of the submerged arc welded metals are almost equal to that of 9% Ni steel. Pilot production of welded 9% Ni steel pipes by the submerged arc welding process has been successfully completed. 20 figs., 10 tables.

COMBUSTION

REFER ALSO TO CITATION(S) 10673

STORAGE

REFER ALSO TO CITATION(S) 10600

9712 (NP—22484) **Underground storage of gas in the United States and Canada. Twenty-sixth annual report on statistics of the Committee on Underground Storage.** (American Gas Association, Arlington, Va. (USA). Committee on Underground Storage). 31 Dec 1976. 27p. Gas Association, Arlington, VA.

All phases of storage operation continued to increase and provided vital supplies of gas during the most severe winter in the history of the industry, exemplified by an increase of some 5 billion cubic feet per day on maximum day output from storage from 30.6 Bcf/d to 35.5 Bcf/d. Details of these and other aspects of storage, including a statement describing the unique function of underground gas storage, a brief history of storage, statistics on aquifers, underground storage in Canada, notes to explain certain column headings, and a map showing locations of storage reservoirs in the United States, are presented. Data in the report are summarized as follows: (1) number of reservoirs—386 in 26 states; an increase of 10 reservoirs over 1975; (2) total capacity—6.927 Tcf; an increase of 283 Bcf over 1975; (3) maximum day output from storage—35.5 Bcf; an increase of 4.9 Bcf from 1975; (4) gas withdrawn from storage—2.060 Tcf; an increase of 328 Bcf over 1975; (5) recoverable gas in storage—4.053 Tcf; a decrease of .188 Bcf from 1975; (6) capital investment—estimated at more than 2.3 billion dollars (includes all physical properties and base gas; and (7) storage compressor stations—1.342 million horsepower; an increase of 24 thousand from 1975. (JRD)

9713 **Storage of liquefied gas in mined caverns.** Claesson, A. (AB Skanska Cementgjuteriet, Stockholm). pp 137-148 of In GASTECH 75 LNG and LPG Technology Congress. Rickmansworth, England; Gastech Exhibitions Ltd. (1976).

From Gastech 75 LNG and LPG technology congress; Paris, France (30 Sep 1975).

See CONF-7509192—.

A world map is given of regions with rock suitable for cavern storage of LPG and LNG. Principles of storage of LPG are given. Storage of LNG in unlined caverns has not been tried, although storage of compressed NG has been done. Preliminary investigations, construction, cost, and environmental aspects are discussed. A panel discussion is included. 9 figs. (DLC)

OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 10601

DRILLING, FRACTURING, AND MINING

REFER ALSO TO CITATION(S) 9700

9714 (LA—6817-PR) **Explosively produced fracture of oil shale. Annual report, March 1976—March 1977.** Carter, W.J. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36. 85p. Dep. NTIS, PC A05/MF A01.

Material properties of oil shale, principally Hugoniots, dynamic spall strength, wave profiles, and elastic constants, are discussed as functions of shale grade and bedding orientation. Nonideal explosive behavior of ANFO and other explosives was investigated both experimentally and theoretically, and the results are given. Finally, these oil shale and explosive properties were integrated into a sophisticated hydrodynamic computer code, representing the first step toward development of a predictive capability for explosive fracture. 81 figures.

OIL PRODUCTION, RECOVERY, AND REFINING

REFER ALSO TO CITATION(S) 9689

IN SITU METHODS, TRUE AND MODIFIED

REFER ALSO TO CITATION(S) 9663

9715 (FE—2346-12) **Energy from in situ processing of Antrim oil shale. Quarterly technical progress report, April—June 1977.** Humphrey, J.P. (Dow Chemical Co., Midland, Mich. (USA). Hydrocarbons and Energy Research Dept.). 19 Jul 1977. Contract EX-76-C-01-2346. 24p. Dep. NTIS, PC A03/MF A01.

Three mineral wells were drilled and cored in the Dow/ERDA series in the south forty acres of the developmental field site. Subcontractor studies on the cores have begun. The Environmental Monitoring Plan has been prepared by the Environmental Research Institute of Michigan. Air injection permeability tests were completed for the Dow/Rhoburn wells, and Well No. 4 was selected for the in situ ignition tests.

REFINING

9716 (FE—2315-18) **Refining and upgrading of synfuels from coal and oil shales by advanced catalytic processes.** Sullivan, R.F.; Rudy, C.E.; Green, D.C.; Chen, H.C. (Chevron Research Co., Richmond, Calif. (USA)). Sep 1977. Contract EF-76-C-01-2315. 29p. Dep. NTIS, PC A03/MF A01.

Batches of shale oil (after a preliminary coking) and solvent-refined coal were hydrorefined. Results are given in some detail. The objective was to determine the feasibility and to estimate the economics of such processing. (LTN)

PURIFICATION

REFER ALSO TO CITATION(S) 9539

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 10722

9717 (SAND—77-1433) **Analysis of low stress oil shale Hugoniots.** Munson, D.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1977. Contract EY-76-C-04-0789. 16p. Dep. NTIS, PC A02/MF A01.

Analysis of low stress Hugoniot data on Anvil Points oil shale was accomplished through careful categorization of data depending upon density. Density is directly related to kerogen content and kerogen content is a strong variable in determining the Hugoniot. For a given density (kerogen content), the shock velocity-particle velocity data show a minimum in shock velocity believed related to yielding in the rock constituent of the oil shale. Low stress Hugoniot data blend smoothly with high pressure data. Further data selection permitted evaluation of the orientation dependence (approximately 15 percent in wave speed) of the shock velocity. Wave propagation speed in a direction normal to the bedding planes is less than that parallel to the bedding planes. A weak minimum in wave speed occurs between 0 and 45°.

WASTE RESEARCH AND MANAGEMENT

9718 (CONF-7605160—, pp 11-30) **Status of oil shale conversion process technology and residuals management.** Hutchins, J. (Oil Shale Consultant, Denver). 1976.

From 1. symposium on management of residuals from synthetic fuels production; Denver, Colorado, USA (25 May 1976).

In Proceedings of the first symposium on management of residuals from synthetic fuels production.

The oil shale deposits in the West and some of the retorting processes and retorts are described. Of the surface retorting processes, only TOSCO II is ready for commercialization. In-situ processes and gasification are also mentioned. The waste and salable products are discussed. It is felt that most of the money spent in environmental studies are just wasted, and a personal view of priorities is offered. (DLC)

ENVIROMENTAL ASPECTS

REFER ALSO TO CITATION(S) 9856

FISSION FUELS

RESERVES

REFER ALSO TO CITATION(S) 10003

9719 (PEL—251) **Environment of deposition and stratigraphy of the uranium-bearing strata around Beaufort West, South Africa.** Horowitz, A. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Apr 1976. 27p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Palynological analyses of some 50 samples collected from uranium-bearing strata - as well as the layers immediately above and below them - around Beaufort West, South Africa, indicate that these sediments were laid down in a wide, rather shallow delta in Late Permian times. Most of the sediments are fluvio-deltaic, and

most of the plant remains were transported from the north, the hinterland in those times. A considerable percentage of the microfossils, e.g. Veryhachium and hystrichospheres, are clearly from a marine environment. The occurrence of marine microfossils in the spectrum, as compared with those of terrestrial provenance, increases considerably southwards.

9720 Uranium distribution and availability. Bowie, S.H.U. (Institute of Geological Sciences, London (UK)). pp 76-82 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

From Symposium on the geology, mining and extractive processing of uranium; London, UK (17 Jan 1977).

See CONF-770146—.

Uranium deposits are not uniformly distributed in the earth's crust but occur in well-defined provinces, mainly in Precambrian terrain and in association with acid igneous rocks. Deposits can conveniently be classified into four main groups; uranium in sandstones; uranium in conglomerates; vein-and similar-type deposits; and other uranium deposits. Most of the presently known reserves occur in sandstones; vein-type deposits are now second in importance; conglomerates are third and other deposits, excluding shales, fourth. The shales of southern Sweden constitute a special case; although recoverable reserves are large (300 000 t U), annual production from them is not likely to exceed 1000 to 2000 t U. The estimation of reserves has been complicated by rapid price rises since 1973 and by uncertainty as to what cost or price levels should be adopted in distinguishing between reserves and resources. Also there has been a tendency for requirements to be revised downwards, and this, together with the apparent acceptance of cost levels of around $30/lb U_3O_8, has relieved the medium-term prospects so far as supply is concerned. In the longer term, however, there is clearly a need for increased prospecting effort on a world scale and for the introduction of new search methods, particularly those aimed at the detection of hidden orebodies. this requirement will be greatly enhanced if there is any retardation in the introduction of fast reactors.

9721 Geology and mineralogy of the Key Lake U-Ni deposits, northern Saskatchewan, Canada. Dahlkamp, F.J.; Tan, B. (Uranerzbergbau G.m.b.H. und Co. K.G., Bonn (Germany, F.R.)). pp 145-157 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

From Symposium on the geology, mining and extractive processing of uranium; London, UK (17 Jan 1977).

See CONF-770146—.

The Key Lake deposit is located at the southeastern rim of the Athabasca Basin in northern Saskatchewan. The first orebody (the Gartner) was discovered in the summer of 1975, and the second (the Deilmann) one year later. At the present stage of investigation - drilling still continues -the following features are apparent. Both orebodies occur in approximately northeast-southwest-striking fracture zones, which affected the crystalline basement as well as the overlying Athabasca sandstone formation. The country rock comprises, from top to bottom, various deposits of glacial origin, the Athabasca sandstone and metasediments of the Wollaston Fold Belt. The main mineralization consists of uranium oxides and nickel sulphides/arsenides. Rarely, some gangue occurs in the form of quartz and carbonates. Drilling results to date indicate, for the Gartner orebody, a length of 1500 m, a width of 10 to 40 m, a depth of 80 m and a grade of up to 45% U_3O_8 + 45% Ni; and, for the Deilmann orebody, a minimum length of 800 m, a width of 10 to more than 100 m, a depth of 150 m and contents of up to 20% U_3O_8 + 25% Ni. The thickness of the glacial overburden varies between 20 and 100 m. Precise reserve calculations are being made, but several difficulties have delayed their completion. The ore is tectonically and lithologically controlled. The presence of geothermometers, as tetragonal α-U_3O_7 (formation temperature, 135°C) and bravoite (137°C), in association with intergrowth textures of other ore minerals, points to a low-temperature origin.

9722 Uranium and granitoids: a tentative interpretation. Moreau, M. (COGEMA, Fontenay-aux-Roses, (France)). pp 83-102 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977). (In French)

From Symposium on the geology, mining and extractive processing of uranium; London, UK (17 Jan 1977).

See CONF-770146—.

In recent years petrologic and geochemical research has been carried out, especially in France, on plutonic rocks. Hence, various mechanism, which could control the distribution of uranium in granitoids, have been reviewed. In France, intragranitic mineralization is considered in relationship to the acidic granitoids (leucogranites), which are well developed in the western Massif Central. In the eastern Massif Central the influence of leucogranites is apparently absent. The leucogranitic uranium mineralizations are located in a thickened sialic area, metamorphosed in the Barrovian grade. In the leucogranite bodies, the geochemical content is higher and uranium is mainly within the microcrystals of non-thoriferous uraninite, whereas the veins are strictly located within the leucogranite bodies. In the ante-Hercynian basement of the eastern Massif Central area, covered unconformably with rather thin Devono-Dinantian series, no obvious affinity with a particular granitoid is seen. In that case the uraninite crystals have a notable thorium grade; the vein-type mineralizations are controlled by the basement cover interaction. The concept of 'fertile' granites should only be applied to thickened sialic crusts, where the mineralizing fluids, originated from the anatexis, are correlated with the vein-type fluids. Such a concept must be rejected when thin or normal sialic crusts are concerned. There, the geochemical preconcentration phenomena do not seem related to vein-type mineralization. Moreover, these concepts have been tentatively extended to other uraniferous areas, such as the Rossing deposit in South West Africa and the Spokane district, Western U.S.A.

9723 Type of uranium deposits in the Austrian Alps. Petrascheck, W.E.; Erkan, E.; Siegl, W. (Montanistische Hochschule, Leoben (Austria). Inst. fuer Geologie und Lagerstaetten). pp 71-75 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

From Symposium on the geology, mining and extractive processing of uranium; London, UK (17 Jan 1977).

See CONF-770146—.

The Permian uranium ore deposits in the Eastern Alps are of the sandstone type, but they show some special features as a result of the orogenic environment of their deposition and of posterior transformation. the deposition was conditioned by a post-Hercynian relief of the Alps: the deposits are localized in lagoonal basins, transverse to the Alpine east-west direction; the type of the deposits was originally tabular; the uranium is connected with organic matter. The Alpine orogeny displaced the original sites of sedimentation, so that now they are situated in different tectonic units, and produced folding, schistosity and an elongated shape of the ore layers in the east-west direction. A mineralogical-petrological comparison of the deposits discloses some differences in composition (uraninite, pitchblende, brannerite, thucholite, uranothorianite and sulphides of Fe and of Cu), which are characteristic for variations of sedimentation and metamorphism. The effect of metamorphism is remarkably low; however, it has a certain influence on the fabrics of the ore-bearing schists and therefore on their porosity; the latter controls the formation of secondary uranium minerals and probably also the possibility of extraction processes. The Permian deposits in Austria are comparatively small (several thousand tons U) and of low grade (about 800 ppm U on average), but some do represent economic prospects.

9724 Uranium in Australia. Ryan, G.R. (Geopeko, Ltd., Darwin (Australia)). pp 24-42 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

From Symposium on the geology, mining and extractive processing of uranium; London, UK (17 Jan 1977).

See CONF-770146—.

The bulk of uranium deposits in Australia can be classified as vein-type (sensu lato), which includes the massive new discoveries of the Alligator Rivers region in the Northern Territory, with indicated reserves of pitchblende already in excess of 350 000 tonnes of contained U_3O_8, as well as bodies of lesser size elsewhere in northern Australia and South Australia. Pitchblende is the most common primary mineral, refractory minerals such as davidite and brannerite predominating in some instances. The ores occupy zones of disruption or shear in metamorphosed Proterozoic rocks, and are generally considered to be of hypogene origin. The origin is most commonly thought to be by desorption of metal from Proterozoic metapelites during anatexis, or from granitic intrusives themselves of possible anatectic origin. Sedimentary uranium akin to the Wyoming rolls is present in the Tertiary of South Australia, where the uranium has been leached from Lower Proterozoic uraniferous inliers. The Carboniferous of central Australia contains sandstone-type deposits that have been subsequently folded and mildly metamorphosed. In Western Australia, and to a lesser extent possibly in central Australia, sedimentary uranium has accumulated in deposits of calcrete that have been formed by replacement of valley-fill deposits in fossil Tertiary drainage channels that contain evaporites. Two unique deposits occur; at Mary Kathleen, where pitchblende is present in allanite in a scapolite-diopside-garnet breccia-conglomerate of Middle Proterozoic age; and the Maureen, where uranium-fluorine-molybdenum mineralization is found in Carboniferous basal standstone. Uraniferous pegmatites are widely distributed, but have yielded no economic deposit of uranium. Proterozoic conglomerates have been extensively tested, but only thorium minerals have so far been discovered.

9725 Uranium abundance and distribution in some granites from northern Scotland and southwest England as indicators of uranium provinces. Simpson, P.R.; Plant, J.; Cope, M.J. (Institute of Geological Sciences, London (UK)). pp 126-139 of In Geology, mining, and

extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

From Symposium on the geology, mining and extractive processing of uranium; London, UK (17 Jan 1977).

See CONF-770146—.

The concentration and distribution of uranium in granitic rocks from the orthotectonic Caledonides (Shetland, Aberdeen and Helmsdale) and the Hercynian province (southwest England) are compared by use of the delayed neutron method of analysis and the Lexan plastic fission track method. This combination of techniques indicates whether anomalously high levels of uranium result from primary magnetic processes or from later enrichment. The geometric mean concentration of uranium in the Caledonian granites studied is 3.9 ppm uranium, with a range of 0.5 to 15.2 ppm; in the Hercynian granites the geometric mean concentration is 10.8 ppm (range, 3.2 to 35.5 ppm). Statistical analysis using a two-tailed Kolmogorov-Smirnov test indicates that the observed differences in the uranium concentration of the two granite suites is significant at the 99% confidence level. Lexan plastic fission track studies show that the Caledonian granites contain only small amounts of primary uraniferous phases and that uranium occurs mainly in secondary minerals, such as hematite and chlorite, in zones of alteration associated with major faults. The uranium in Hercynian granites is shown to occur mainly in minerals such as zircon, apatite and sphene. The results obtained indicate that the uranium vein-type mineralization of southwest England is comagmatic with the uranium-enriched granites and is not simply the result of later concentration of uranium from the granites by processes such as kaolinization or weathering. Previous work based on whole-rock analysis for uranium, radiometric studies or U/K ratios without mineralogical control is shown to require cautious interpretation because of the different modes of occurrence of the contained uranium. Implications of the results are discussed.

9726 Study of Spanish uraniferous sandstones. Merino, J.L.; Josa, J.M. (Junta de Energia Nuclear, Madrid (Spain)). pp 63-70 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

From International symposium on geology, mining and extractive processing of uranium; London, UK (17 - 19 Jan 1977).

Spain is hopeful about the development of its uraniferous sandstones as an important source of uranium, study of which has begun on ores from the Mazarete region of Guadalajara. They contain approximately 0.1% U_3O_8 and are of medium hardness. Results are presented of investigations into the following; grinding and thickening, leaching (conventional and heap leaching), countercurrent decantation and slurry characteristics, solvent extraction and precipitation, and effluent neutralization and radioactive decontamination. Leaching with dilute acid gives a high uranium recovery with a low acid consumption. High solids pulp plus strong acid leaching does not increase the uranium recovery, but the CCD results are better than those obtainable conventionally. The ore has a high content of clayey fines, and decantation and thickening of the tailings are difficult. The addition of flocculant and the use of high unit areas are necessary. Overflows are not very clear and underflows have low solids concentration. Uranium recovery from the pregnant liquors with the use of the Amex process is fairly good: the raffinates are neutralized with limestone and milk of lime; radium is precipitated with barium chloride.

9727 Uranium distribution and availability. Bowie, S.H.U. (Institute of Geological Sciences, London (UK)). pp 76-82 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

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Uranium deposits are not uniformly distributed in the earth's crust but occur in well-defined provinces, mainly in Precambrian terrain and in association with acid igneous rocks. Deposits can conveniently be classified into four main groups; uranium in sandstones; uranium in conglomerates; vein-and similar-type deposits; and other uranium deposits. Most of the presently known reserves occur in sandstones; vein-type deposits are now second in importance; conglomerates are third and other deposits, excluding shales, fourth. The shales of southern Sweden constitute a special case; although recoverable reserves are large (300 000 t U), annual production from them is not likely to exceed 1000 to 2000 t U. The estimation of reserves has been complicated by rapid price rises since 1973 and by uncertainty as to what cost or price levels should be adopted in distinguishing between reserves and resources. Also there has been a tendency for requirements to be revised downwards, and this, together with the apparent acceptance of cost levels of around $30/lb U_3O_8, has relieved the medium-term prospects so far as supply is concerned. In the longer term, however, there is clearly a need for increased prospecting effort on a world scale and for the introduction of new search methods, particularly those aimed at the detection of hidden orebodies. this requirement will be greatly enhanced if there is any retardation in the introduction of fast reactors.

9728 Geology and mineralogy of the Key Lake U-Ni deposits, northern Saskatchewan, Canada. Dahlkamp, F.J.; Tan, B. (Uranerzbergbau G.m.b.H. und Co. K.G., Bonn (Germany, F.R.)). pp 145-157 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

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The Key Lake deposit is located at the southeastern rim of the Athabasca Basin in northern Saskatchewan. The first orebody (the Gartner) was discovered in the summer of 1975, and the second (the Deilmann) one year later. At the present stage of investigation - drilling still continues -the following features are apparent. Both orebodies occur in approximately northeast-southwest-striking fracture zones, which affected the crystalline basement as well as the overlying Athabasca sandstone formation. The country rock comprises, from top to bottom, various deposits of glacial origin, the Athabasca sandstone and metasediments of the Wollaston Fold Belt. The main mineralization consists of uranium oxides and nickel sulphides/arsenides. Rarely, some gangue occurs in the form of quartz and carbonates. Drilling results to date indicate, for the Gartner orebody, a length of 1500 m, a width of 10 to 40 m, a depth of 80 m and a grade of up to 45% U_3O_8 + 45% Ni; and, for the Deilmann orebody, a minimum length of 800 m, a width of 10 to more than 100 m, a depth of 150 m and contents of up to 20% U_3O_8 + 25% Ni. The thickness of the glacial overburden varies between 20 and 100 m. Precise reserve calculations are being made, but several difficulties have delayed their completion. The ore is tectonically and lithologically controlled. The presence of geothermometers, as tetragonal α-U_3O_7 (formation temperature, 135°C) and bravoite (137°C), in association with intergrowth textures of other ore minerals, points to a low-temperature origin.

9729 Metallogenesis of Canadian uranium deposits, a review. McMillan, R.H. (Western Mines, Ltd., Toronto, Ontario (Canada)). pp 43-55 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

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Canada is favoured with uranium ore reserves that are among the largest in the world - these reserves are contained in three types of deposit. The igneous-metamorphic type is represented by the Bancroft district of Ontario, where more than 11 000 000 lb U_3O_8 has been produced from pegmatites emplaced in granulite-facies metamorphic rocks. The detrital deposits at Elliot Lake, with production in excess of 190 000 000 lb of U_3O_8 by 1976, constitute one of the largest uranium ore districts in the world. The Elliot Lake deposits and a similar deposit at Agnew Lake occur in puritic quartz-pebble conglomerates, which were deposited in palaeostream channels. These deposits were derived from uranium-rich granitic rocks located north of the depositional area and concentrated mainly as detrital heavy minerals. Hydrogenic uranium deposits are represented in the Proterozoic of Canada in shales and several epigenetic types. The epigenetic deposits are generally characterized by pitchblende and hematite, and are generally enriched in Ni, Co, Ag, Cu and As. Chemically favourable graphitic and (or) calcareous shelf-facies metasedimentary strata commonly form the host rocks. The Port Radium and Beaverlodge deposits are 'classical' veins, which exhibit strong structural control. Stratigraphic control appears more important in the recently discovered 'unconformity veins' that occur near the base of the Athabasca Sandstone in Saskatchewan. At the Rabbit, Key and Cluff Lake deposits most of the mineralization occurs in basement rocks within 100 m of the unconformity, but ore is also found within the regolith and overlying orthoquartzites. Production from the Athabasca area deposits will probably surpass that from the Elliot Lake district in the future.

9730 Uranium and granitoids: a tentative interpretation. Moreau, M. (COGEMA, Fontenay-aux-Roses, (France)). pp 83-102 of In Geology, mining, and extractive processing or uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977). (In French)

From International symposium on geology, mining and extractive processing of uranium; London, UK (17 - 19 Jan 1977).

In recent years petrologic and geochemical research has been carried out, especially in France, on plutonic rocks. Hence, various mechanism, which could control the distribution of uranium in granitoids, have been reviewed. In France, intragranitic mineralization is considered in relationship to the acidic granitoids (leucogranites), which are well developed in the western Massif Central. In the eastern Massif Central the influence of leucogranites is apparently absent. The leucogranitic uranium mineralizations are located in a thickened sialic area, metamorphosed in the Barrovian grade. In the leucogranite bodies, the geochemical content is higher and uranium is mainly within the microcrystals of non-thoriferous uraninite, whereas the veins are strictly located within the leucogranite bodies. In the ante-Hercynian basement of the eastern Massif Central area,

covered unconformably with rather thin Devono-Dinantian series, no obvious affinity with a particular granitoid is seen. In that case the uraninite crystals have a notable thorium grade; the vein-type mineralizations are controlled by the basement cover interaction. The concept of 'fertile' granites should only be applied to thickened sialic crusts, where the mineralizing fluids, originated from the anatexis, are correlated with the vein-type fluids. Such a concept must be rejected when thin or normal sialic crusts are concerned. There, the geochemical preconcentration phenomena do not seem related to vein-type mineralization. Moreover, these concepts have been tentatively extended to other uraniferous areas, such as the Rossing deposit in South West Africa and the Spokane district, Western U.S.A.

9731 Type of uranium deposits in the Austrian Alps. Petrascheck, W.E.; Erkan, E.; Siegl, W. (Montanistische Hochschule, Leoben (Austria). Inst. fuer Geologie und Lagerstaetten). pp 71-75 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

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The Permian uranium ore deposits in the Eastern Alps are of the sandstone type, but they show some special features as a result of the orogenic environment of their deposition and of posterior transformation. the deposition was conditioned by a post-Hercynian relief of the Alps: the deposits are localized in lagoonal basins, transverse to the Alpine east-west direction; the type of the deposits was originally tabular; the uranium is connected with organic matter. The Alpine orogeny displaced the original sites of sedimentation, so that now they are situated in different tectonic units, and produced folding, schistosity and an elongated shape of the ore layers in the east-west direction. A mineralogical-petrological comparison of the deposits discloses some differences in composition (uraninite, pitchblende, brannerite, thucholite, uranothorianite and sulphides of Fe and of Cu), which are characteristic for variations of sedimentation and metamorphism. The effect of metamorphism is remarkably low; however, it has a certain influence on the fabrics of the ore-bearing schists and therefore on their porosity; the latter controls the formation of secondary uranium minerals and probably also the possibility of extraction processes. The Permian deposits in Austria are comparatively small (several thousand tons U) and of low grade (about 800 ppm U on average), but some do represent economic prospects.

9732 Uranium in Australia. Ryan, G.R. (Geopeko, Ltd., Darwin (Australia)). pp 24-42 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

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The bulk of uranium deposits in Australia can be classified as vein-type (sensu lato), which includes the massive new discoveries of the Alligator Rivers region in the Northern Territory, with indicated reserves of pitchblende already in excess of 350 000 tonnes of contained U_3O_8, as well as bodies of lesser size elsewhere in northern Australia and South Australia. Pitchblende is the most common primary mineral, refractory minerals such as davidite and brannerite predominating in some instances. The ores occupy zones of disruption or shear in metamorphosed Proterozoic rocks, and are generally considered to be of hypogene origin. The origin is most commonly thought to be by desorption of metal from Proterozoic metapelites during anatexis, or from granitic intrusives themselves of possible anatectic origin. Sedimentary uranium akin to the Wyoming rolls is present in the Tertiary of South Australia, where the uranium has been leached from Lower Proterozoic uraniferous inliers. The Carboniferous of central Australia contains sandstone-type deposits that have been subsequently folded and mildly metamorphosed. In Western Australia, and to a lesser extent possibly in central Australia, sedimentary uranium has accumulated in deposits of calcrete that have been formed by replacement of valley-fill deposits in fossil Tertiary drainage channels that contain evaporites. Two unique deposits occur; at Mary Kathleen, where pitchblende is present in allanite in a scapolite-diopside-garnet breccia-conglomerate of Middle Proterozoic age; and the Maureen, where uranium-fluorine-molybdenum mineralization is found in Carboniferous basal sandstone. Uraniferous pegmatites are widely distributed, but have yielded no economic deposit of uranium. Proterozoic conglomerates have been extensively tested, but only thorium minerals have so far been discovered.

9733 Uranium abundance and distribution in some granites from northern Scotland and southwest England as indicators of uranium provinces. Simpson, P.R.; Plant, J.; Cope, M.J. (Institute of Geological Sciences, London (UK)). pp 126-139 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

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The concentration and distribution of uranium in granitic rocks from the orthotectonic Caledonides (Shetland, Aberdeen and Helmsdale) and the Hercynian province (southwest England) are compared by use of the delayed neutron method of analysis and the Lexan plastic fission track method. This combination of techniques indicates whether anomalously high levels of uranium result from primary magnetic processes or from later enrichment. The geometric mean concentration of uranium in the Caledonian granites studied is 3.9 ppm uranium, with a range of 0.5 to 15.2 ppm; in the Hercynian granites the geometric mean concentration is 10.8 ppm (range, 3.2 to 35.5 ppm). Statistical analysis using a two-tailed Kolmogorov-Smirnov test indicates that the observed differences in the uranium concentration of the two granite suites is significant at the 99% confidence level. Lexan plastic fission track studies show that the Caledonian granites contain only small amounts of primary uraniferous phases and that uranium occurs mainly in secondary minerals, such as hematite and chlorite, in zones of alteration associated with major faults. The uranium in Hercynian granites is shown to occur mainly in minerals such as zircon, apatite and sphene. The results obtained indicate that the uranium vein-type mineralization of southwest England is comagmatic with the uranium-enriched granites and is not simply the result of later concentration of uranium from the granites by processes such as kaolinization or weathering. Previous work based on whole-rock analysis for uranium, radiometric studies or U/K ratios without mineralogical control is shown to require cautious interpretation because of the different modes of occurrence of the contained uranium. Implications of the results are discussed.

9734 Uranium geology and prospecting in Greenland. Steenfelt, A.; Neilson, B.L.; Secher, K. (Geological Survey of Greenland, Copenhagen (Denmark)). pp 8-12 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

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The Geological Survey of Greenland is responsible for most of the uranium and thorium prospecting activity in Greenland, which involves airborne gamma spectrometry and scintillometry, geochemical sampling, geological investigations and ground scintillometry. Since 1971 large areas of east and west Greenland have been investigated by aerial surveys, geochemical sampling and most of the detailed scintillometric work having been restricted to small areas in east Greenland. Anomalous radioactivity in west Greenland is recorded from carbonatite intrusions, and from units in Proterozoic and Archaean gneisses. No mineralization has been found to date. In south Greenland investigations have been centred on the uranium and thorium deposit at Kvanefjeld, which is situated in a corner of the Ilimaussaq alkaline intrusion. The coincidence of favourable conditions during the differentiation and crystallization of the magma led to an extreme enrichment of uranium and thorium in the rocks that were last formed - the lujavrites. The deposit comprises parts of the lujavrites and a secondary enrichment zone in the contact between lujavrite and basaltic cover rocks. Reasonably assured reserves are 5800 t U with a grade of 310 ppm U. In the Caledonides of east Greenland some gneisses in basement cores, a dark siltstone in late Precambrian sediments and the Devonian acid magmatic rocks are characterized by a higher radiation level. A number of small mineral occurrences have been found, the majority of which are associated with the Devonian acid magmatic rocks.

9735 Application of gamma-spectrometry methods for delineation of ore zones in ZabajZal'e. Krendelev, F.P.; Mironov, A.G.; Gofman, A.M. (AN SSSR, Uland Udeh. Geologicheskij Inst.). *Geol. Geofiz.;* No. 8, 67-75(Aug 1976). (In Russian).

A study has been made of radiogeochemical peculiarities of some deposits of Au, Mo and W in Trans-Baikal region. It has been found that in Au deposits of the Balei type regions of adularization and quartz formation can reliably be registered by low Th content and Th/U ratios. An increased content of U is characteristic of molybdenite mineralisation regions, and that of K of tungstite deposits. Gamma-spectrometric methods allow reliable fixation of deposits of the elements under consideration.

9736 Primary occurence of uranium-bitumen mineralization in India. Bogdanov, Yu.V.; Prakash, R.; Mirkina, S.L.; Onoshko, I.S. *Dokl. Akad. Nauk SSSR;* No. 1, 168-170(Sep 1975). (In Russian).

The uranobituminous mineralization is discovered in 1974 in the Sonrai ore-bearing province located in the northern part of the Indian crystalline shield. Mineralized zones of drecciation with uranium bitumens have been observed to occur in ore-bearing horizons with impregnated copper and lead-and-zinc mineralization. The uranobituminous mineralization is confined to the tension joints in clayey and sandy carbonate rocks of the upper part of the Sonrai series. Zones of crush reach 2 m in thickness. Uranium bitumens is a block compact variety of a relatively weak lustre and columna; fracture; they are insoluble in organic solvents and alkali. According to the chemical analysis, the uranium content in bitumens makes up several per cent (up to 3.18%V). As is shown by the laboratory studies the bitumens are related to kerite-anthraxylon varieties, while the uranium mineral - to the group of uranium silicates. Isotopelead

age determination suggests the uranobituminous mineralization to be of Early Mesozoic age (210-240 m.y.).

EXPLORATION

REFER ALSO TO CITATION(S) 9734

9737 Pattern recognition applied to uranium prospecting. Briggs, P.L.; Press, F. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Earth and Planetary Sciences). *Nature (London);* **268**: No. 5616, 125-127(14 Jul 1977).

It is stated that pattern recognition techniques provide one way of combining quantitative and descriptive geological data for mineral prospecting. A quantified decision process using computer-selected patterns of geological data has the potential for selecting areas with undiscovered deposits of uranium or other minerals. When a natural resource is mined more rapidly than it is discovered, its continued production becomes increasingly difficult, and it has been noted that, although a considerable uranium reserve may remain in the U.S.A., the discovery rate for uranium is decreasing exponentially with cumulative exploration footage drilled. Pattern recognition methods of organising geological information for prospecting may provide new predictive power, as well as insight into the occurrence of uranium ore deposits. Often the task of prospecting consists of three stages of information processing: (1) collection of data on known ore deposits; (2) noting any regularities common to the known examples of an ore; (3) selection of new exploration targets based on the results of the second stage. A logical pattern recognition algorithm is here described that implements this geological procedure to demonstrate the possibility of building a quantified uranium prospecting guide from diverse geologic data.

9738 Uranium exploration technology. Dodd, P.H. (USAEC Grand Junction Office, Colo.). pp 158-171 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

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See CONF-770146—.

Uranium exploration methods and technology have evolved from three decades of experience, stimulated intermittently by a historically fluctuating demand for uranium. The methods generally applied are reviewed. The recent trends to utilize some of the less commonly employed methods to improve exploration for concealed deposits and to evaluate lower-grade resources in unfamiliar geologic environments are noted. Recent developments of technology to support exploration emphasize nuclear geophysics, such as sensitive gamma-ray spectrometry, direct uranium logging by use of fission neutron techniques, more sophisticated radon and helium emanometry, and an increasing interest in direct geophysical and geochemical measurements by use of neutron-neutron and magnetic susceptibility. Although each improved technique improves the technology, it is the possible combination of techniques that will optimize exploration. To be most effective the techniques should be integrated and exploration methods predicated on sound geological-geochemical principles of uranium ore genesis.

9739 Method of detecting small or indistinct radioactive sources by airborne gamma-ray spectrometry. Linden, A.H.; Akerblom, G. (Geological Survey of Sweden, Stockholm (Sweden)). pp 113-120 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

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The geological survey of Sweden (SGU) has developed a system for airborne radiometric surveying which facilitates the detection of small radioactive sources such as poorly exposed uranium mineralization. By flying at a low height (30 m) and measuring over a short time period, the area represented by each measuring station is kept to a minimum. To achieve sufficient precision the entire spectrum between 0.45 and 2.85 MeV is utilized for the calculation of the radiation related to K, U and Th. The results are displayed in the form of a map, on which every measuring station is represented by columns in three colors, one for each element. The map not only indicates point anomalies but also gives a picture of the distribution of the elements over a large area. It can therefore be of assistance in geological mapping in addition to its application to uranium prospecting.

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9744 Geochemistry of aluminium thorium and uranium in the process of crusting and bauxite formation. Bogdanovich, N.P.; Gottikh, R.P. (Vsesoyuznyj Nauchno-Issledovatel'skij Inst. Yadernoj Geofiziki i Geokhimii, Moscow (USSR)). pp no.25 p.8-33 of In Gamma-spectrometry methods in exploration and prospecting of mineral raw materials. Moscow; ONTI VNIIYAGG (1975). (In Russian)

The forms aluminium, thorium and uranium occur in magmatic rocks, the main source of these elements in a sedimentation cycle, are considered. When thorium occurs in the mother rocks in a diffused state, the main geochemical features of aluminium and thorium in the zone of hypergenesis are similar. Particular attention is given to the behaviour of uranium in Gibbs' and Bemit's profiles of weathering. In Bemit's profile the behaviour of uranium, thorium and aluminium is identical, while in Gibbs' one uranium is removed from the upper zones and accumulated in the central hydromica medium. During the transfer and re-deposition of the bauxite material there occurs a redistribution of thorium and uranium, which reflects the nonuniformity of their distribution in bauxites.

MINING

REFER ALSO TO CITATION(S) 9663

9745 Mining and processing of uranium deposits in Salamanca, Spain. Gomez Jaen, J.P.; Otero, J.; Serrano, J.R.; Membrillera, J.R. (Empresa Nacional del Uranio, S.A., Madrid, (Spain)); Josa, J.M. (Junta de Energia Nuclear, Madrid (Spain)). pp 103-108 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

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See CONF-770146—.

In July, 1974, Empresa Nacional del Uranio, S.A. (ENUSA), took the decision to mine uranium in the province of Salamanca, based on geological and processing studies carried out by the Junta de Energia Nuclear (JEN). The milling plant was designed by JEN and assembled by ENUSA, and operations were begun on 22 May, 1975. The orebody, FE-1, is composed of slate of Cambrain age and the fissures are filled by primary minerals. Secondary minerals are impregnated in the zone affected by the hydrostatic level. The orebody is of the stockwork type in which carbonaceous matter has acted as a reducing agent. The average grade of the ore is 0.09% U_3O_8 at a cutoff grade of 0.02% U_3O_8: the deposit is therefore among the lowest-grade deposits that are currently mined. Annual production is 1 200 000 t of rock, of which 200 000 t is ore-bearing. The milling plant uses a static heap-leaching method, followed by solvent extraction (tertiary amines) and precipitation by ammonia. Joint studies by JEN and ENUSA have led to the introduction of modifications that have increased the production capacity from 75 to 112 t U_3O_8 per annum with no significant alteration in the initial planned investment. The total recovery after processing is 75% of the U_3O_8 contained in the ore. Approximately 100 people are employed in the overall operation. ENUSA has decided to expand operations in Salamanca with the construction of a new milling plant (technological aid by JEN), which will be capable of processing 825 000 t of ore per year, with an annual production of 500 t U_3O_8. The new plant is expected to begin operations in 1979.

9746 Mining and processing of uranium deposits in Salamanca, Spain. Gomez Jaen, J.P.; Otero, J.; Serrano, J.R.; Membrillera, J.R. (Empresa Nacional del Uranio, S.A., Madrid, (Spain)); Josa, J.M. (Junta de Energia Nuclear, Madrid (Spain)). pp 103-108 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

From International symposium on geology, mining and extractive processing of uranium; London, UK (17 - 19 Jan 1977).

In July, 1974, Empresa Nacional del Uranio, S.A. (ENUSA), took the decision to mine uranium in the province of Salamanca, based on geological and processing studies carried out by the Junta de Energia Nuclear (JEN). The milling plant was designed by JEN and assembled by ENUSA, and operations were begun on 22 May, 1975. The orebody, FE-1, is composed of slate of Cambrain age and the fissures are filled by primary minerals. Secondary minerals are impregnated in the zone affected by the hydrostatic level. The orebody is of the stockwork type in which carbonaceous matter has acted as a reducing agent. The average grade of the ore is 0.09% U_3O_8 at a cutoff grade of 0.02% U_3O_8: the deposit is therefore among the lowest-grade deposits that are currently mined. Annual production is 1 200 000 t of rock, of which 200 000 t is ore-bearing. The milling plant uses a static heap-leaching method, followed by solvent extraction (tertiary amines) and precipitation by ammonia. Joint studies by JEN and ENUSA have led to the introduction of modifications that have increased the production capacity from 75 to 112 t U_3O_8 per annum with no significant alteration in the initial planned investment. The total recovery after processing is 75% of the U_3O_8 contained in the ore. Approximately 100 people are employed in the overall operation. ENUSA has decided to expand operations in Salamanca with the construction of a new milling plant (technological aid by JEN), which will be capable of processing 825 000 t of ore per year, with an annual production of 500 t U_3O_8. The new plant is expected to begin operations in 1979.

FEED PROCESSING

REFER ALSO TO CITATION(S) 9746, 9822, 9823, 9824, 9825, 9826, 9827, 9828, 9829, 9830, 9831, 9832, 9833, 10721

9747 Bacterially assisted plant process for leaching uranium ores. Derry, R.; Le Roux, N.W. (Warren Spring Lab., Stevenage (UK)); Garrett, K.H.; Smith, S.E. pp 56-62 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

From Symposium on the geology, mining and extractive processing of uranium; London, UK (17 Jan 1977).

See CONF-770146—.

The development of a process for uranium extraction in which beds of ore are leached with bacterially regenerated lixiviant is described. The process has been examined at pilot scale and extractions 95% were obtained from ore containing 0.12% U_3O_8. In the process a series of submerged beds of -3-mm ore was leached continuously for up to 10 days at 50°C and pH 1.2. The uranium was recovered by ion exchange and the ferrous solution regenerated by the action of Thiobacillus ferrooxidans at 30°C. The overall acid consumption was lower than that used in conventional sulfuric acid leaching. Economic analysis shows cost savings of around $2/kg (1971 prices) as compared with the conventional process, largely because grinding is minimized and a separate solid-liquid separation step is avoided.

9748 (RISO—355) Sulfatizing roasting of a Greenlandic uranium ore, reactivity of minerals and recovery. Gamborg Hansen, J.K. (Risoe National Lab., Roskilde (Denmark)). Mar 1977. 143p. Dep. NTIS (US Sales Only), PC A07/MF A01.

Uranium in the lujavrite ore from Kvanefjeld, South Greenland, can be solubilized by sulfatizing roasting at 700°C. The reactivity of various lujavrite minerals in the roasting process and the mechanism of the reaction were investigated by X-ray diffraction, optical microscopy, electron microprobe, thermal analysis, Moessbauer and infrared spectroscopy. Soluble sulfates are formed on the surface of the grains; an outer zone of the grains is transformed; usually a core remains unchanged. Variations in uranium recovery can be explained by variations in the contents of the uranium-bearing minerals, steenstrupine and uranium-containing pigmentary material (altered Zr containing silicate minerals), and in the degree of alteration of steenstrupine. Characterization of these minerals required many qualitative and a few quantitative electron microprobe analyses.

9749 Nuclear Fuel Complex - a landmark of indigenous nuclear technology. Katiyar, H.C. (Nuclear Fuel Complex, Hyderabad (India)). *Nucl. India;* **15**: No. 5, 1,4-7(Jan 1977).

The Nuclear Fuel Complex (NFC) set up in India for manufacturing fuel and related hardware has proved to be a significant step towards self-sufficiency and saving of foreign exchange. The complex is involved in the entire operations starting from processing of raw material concentrates to finishing of fuel assemblies and other zircaloy reactor components. The complex consists of the following units : (1) Zirconium Oxide Plant, (2) Zirconium Sponge Plant, (3) Zircaloy Fabrication Plant, (4) Uranium Oxide Plant, (5) Ceramic Fabrication Plant, (6) Enriched Uranium Oxide Plant, (7) Enriched Fuel Fabrication Plant, (8) Special Materials Plant and (9) Titanium Plant. A brief description of the activities of the various units of the

complex are given. The effluent management scheme is outlined. The requirements and cost of fuel and zircaloy components for the power stations at Tarapur, Kota and Kalpakkam are mentioned.

9750 Hydrometallurgical heap processing of the uranium ore from Forstau (Austria). Floeter, W.; Wirth, G. (Uranerzbergbau G.m.b.H. und Co. K.G., Bonn (Germany, F.R.)). pp 121-125 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977). (In German)

From Symposium on the geology, mining and extractive processing of uranium; London, UK (17 Jan 1977).

See CONF-770146—.

The sedimentary ore from Forstau originates from an underground mine. The run-of-mine ore is - 100 mm in size. The uranium content of the ore is between 0.03 and 0.15%. The carbonate content averages 6%. Investigations to date have shown that, after milling to - 1 mm, the ore can be submitted to conventional hydrometallurgical treatment, the recovery by acid leaching being 95% and by alkaline leaching 85%. To apply a suitable technical process in the Forstau Valley, which is a resort area, the following criteria had to be considered: (1) minimum environmental impact; (2) no industrial production of sulfuric acid locally; (3) scarcity of sites sufficient for mine and mill buildings and installations; and (4) no possibility for tailings disposal in the Forstau Valley. Under these conditions the following process was developed: (1) selective mining of ore and gangue; (2) crushing of the ore below 4 mm; (3) desliming of the ore at 10 μm with separate agitated leaching of the fines; (4) vat leaching of the coarse ore (possibly together with pelletized fines), using acid produced by bacteriological action with a curing time of 1 to 2 weeks; (5) washing of the leached ore with water and recirculation of the wash solution in the next vat in countercurrent; and (6) conventional filtration of the pregnant solutions, ion exchange, yellow-cake precipitation and drying.

9751 Study of Spanish uraniferous sandstones. Merino, J.L.; Josa, J.M. (Junta de Energia Nuclear, Madrid (Spain)). pp 63-70 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

From Symposium on the geology, mining and extractive processing of uranium; London, UK (17 Jan 1977).

See CONF-770146—.

Spain is hopeful about the development of its uraniferous sandstones as an important source of uranium, study of which has begun on ores from the Mazarete region of Guadalajara. They contain approximately 0.1% U_3O_8 and are of medium hardness. Results are presented of investigations into the following; grinding and thickening, leaching (conventional and heap leaching), countercurrent decantation and slurry characteristics, solvent extraction and precipitation, and effluent neutralization and radioactive decontamination. Leaching with dilute acid gives a high uranium recovery with a low acid consumption. High solids pulp plus strong acid leaching does not increase the uranium recovery, but the CCD results are better than those obtainable conventionally. The ore has a high content of clayey fines, and decantation and thickening of the tailings are difficult. The addition of flocculant and the use of high unit areas are necessary. Overflows are not very clear and underflows have low solids concentration. Uranium recovery from the pregnant liquors with the use of the Amex process is fairly good: the raffinates are neutralized with limestone and milk of lime; radium is precipitated with barium chloride.

9752 Leaching methods without preliminary grinding in the processing of uranium ores. Michel, P. (COGEMA, Fontenay-aux-Roses (France)). pp 13-19 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977). (In French)

From Symposium on the geology, mining and extractive processing of uranium; London, UK (17 Jan 1977).

See CONF-770146—.

Heap leaching of uranium ores that have not been subjected to any mechanical preparation has been carried out for many years. This has been done primarily on marginal or lean ores, necessarily extracted in the normal course of mining and quarrying. The method can be applied to some slightly richer ores, after crushing, on recoverable areas, as additional cheap production. A variation of this process, accelerated in vats or on recoverable areas, could be a principal means of production for ores of average grade from deposits with limited reserves. It may then be possible to obtain uranium concentrates at competitive prices. In-situ leaching was originally used to exhaust mined areas by treating existing workings with reagents and recovering the leach liquors. It has been extended to operations that include a limited amount of mining (mixed method). In-situ leaching, sensu stricto, does not imply preliminary mining operations except for the drilling of holes to inject and recover the solutions and eventually, the breaking up of the exploitation area. In-situ leaching is only applicable provided that the problems associated with isolation of the deposit from the hydrological network have been resolved (risks of pollution or flooding), and that reagents can be brought into contact with mineralized zones.

9753 Amine synergism in uranium extraction. Rinelli, G.; Abbruzzese, C. (Consiglio Nazionale delle Ricerche, Rome (Italy)). pp 20-23 of In Geology, mining, and extractive processing or uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

From Symposium on the geology, mining and extractive processing of uranium; London, UK (17 Jan 1977).

See CONF-770146—.

Commercial products based on C_8 to C_{12} tertiary amine mixtures are now widely used in the solvent extraction of uranium from sulfuric pregnant solutions. The satisfactory results generally obtained have never required an analysis of the synergistic effects of amine combinations similar to that carried out for the organophosphorus compounds. In the research described the increase in the extraction power of an organic phase composed of an amine binary mixture was studied with regard to an aqueous solution from the sulfuric acid treatment of uranium ore. On the basis of the experimental results obtained, it is possible to select the best composition of the amine mixture to ensure a percentage increase in uranium recovery. Bearing in mind the tendency for the yellow-cake price to rise, the study is considered to be a useful contribution in the context of commercial products currently available on the market.

9754 Improvements in processes and equipment for the uranium industry and their effect on plant costs. Skelton, R.L.; Scowen, P.A. (Head Wrightson Ltd., Stockton-on-Tees (UK)). pp 140-144 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

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Various processes have been reported that utilize strong acids to leach uranium ores. The United Kingdom Atomic Energy Authority has carried out extensive testwork and has patented a process. Plant requirements for strong acid leaching are discussed and areas of potential cost savings highlighted. A new design of mixer-settler development by Holmes and Narver, the 'low-profile' mixer-settler, is discussed and potential cost savings are emphasized. Laboratory-scale test results of the strong acid leaching process are given for various ore types. The extraction of the maximum percentage of uranium is discussed in relation to optimum conditions of curing time, temperature, ore particle size and use of oxidant. Capital and operating costs for various plant sections are compared for dilute and strong acid processes.

9755 Bacterially assisted plant process for leaching uranium ores. Derry, R.; Le Roux, N.W. (Warren Spring Lab., Stevenage (UK)); Garrett, K.H.; Smith, S.E. pp 56-62 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

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9756 Hydrometallurgical heap processing of the uranium ore from Forstau (Austria). Floeter, W.; Wirth, G. (Uranerzbergbau G.m.b.H. und Co. K.G., Bonn (Germany, F.R.)). pp 121-125 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977). (In German)

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9758 Amine synergism in uranium extraction. Rinelli, G.; Abbruzzese, C. (Consiglio Nazionale delle Ricerche, Rome (Italy)). pp 20-23 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

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ENRICHMENT

9760 (K/CSD/TM—17) SCOPE: synergistic computer optimization of planning for enrichment status report. DeLozier, R.C.; Kelleher, D.M.; Cross, K.E. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). Jul 1977. Contract W-7405-ENG-26. 36p. Dep. NTIS, PC A03/MF A01.

The computer program SCOPE was developed to provide a schedule for filling orders for enriched uranium while constrained by: (1) the size and efficiency of the current and projected uranium enrichment complex; (2) the current levels of "yard inventory" of enriched uranium below 5 percent; and (3) variable conditions such as projected schedule of power availability, cascade tails assay, and the ERDA "Order Book" of firm and projected orders for enriched uranium. The program can be extended to include several more enrichment plants, such as a centrifuge plant. Output includes a detailed daily set of feed and withdrawal rates for each plant and a survey of all yard inventories at the end of each month. The Phase I program does not contain cost tables; therefore, it cannot consider costs directly at this time. However, it does use heuristic procedures to establish preproduction schedules that will result in lower ERDA feed usage and, consequently, lower costs. The program currently relies on two files for data used in calculations. The first data set consists of all current UF_6 inventories at the plants; the second data set contains the ERDA enrichment requirements.

9761 Method of isotope separation by chemi-ionization. Wexler, S.; Young, C.E. (to Energy Research and Development Administration). US Patent 4,024,217. 17 May 1977. Filed date 23 May 1975. 8p. PAT-APPL-580,499.

A method is disclosed for separating isotopes in an isotopic mixture by aerodynamically accelerating a gaseous compound to form a jet of molecules, and passing the jet through a stream of electron donor atoms whereby an electron transfer takes place, thus forming negative ions of the molecules. The molecular ions are then passed through a radiofrequency quadrupole mass filter to separate the specific isotopes. cThis method may be used for any compounds having a sufficiently high electron affinity to permit negative ion formation, and is especially useful for the separation of plutonium and uranium isotopes. 10 claims, 1 figure.

9762 Apparatus for continuous-process separation of gases from a mixture. (to Ultra-Centrifuge Nederland N.V., The Hague). Netherlands Patent 7,514,822/A/. 19 Dec 1975. 8p. (In Dutch).

6 figs.

Separation units for a uranium enrichment plant, which are interchangeable and interconnectible are described. By switching fewer or more units into one production phase, the required degree of enrichment may be obtained.

9763 New separation process. Miyake, T.; Takeda, K.; Ikeda, A.; Imamura, K.; Seko, M. (to Asahi Chemical Industry Co. Ltd., Osaka (Japan)). Japanese Patent 1976-144,898/A/. 7 Jun 1975. 6p. (In Japanese).

The object is to use anion exchange resins of good true sphericity to efficiently separate uranium isotopes. In the separation of isotopes while effecting oxidation and reduction in an interface between zone of uranium adsorption and zone of reducing agent adjacent thereto, or an interface between zone of uranium adsorption and zone of oxidizing agent, or both the interfaces described above, in a system where anion exchanger is present, the anion exhanger comprises anion exchange resins which are granular and which include more than 80% of total grains whose largest diameter is less than twice of the smallest diameter.

GASEOUS DIFFUSION

9764 Traversing probe system. Mashburn, D.N.; Stevens, R.H.; Woodall, H.C. (to Energy Research and Development Administration). US Patent 4,016,768. 12 Apr 1977. Filed date 15 Mar 1976. 8p. PAT-APPL-667,005.

This invention comprises a rotatable annular probe-positioner which carries at least one radially disposed sensing probe, such as a Pitot tube having a right-angled tip. The positioner can be coaxially and rotatably mounted within a compressor casing or the like and then actuated to orient the sensing probe as required to make measurements at selected stations in the annulus between the positioner and compressor casing. The positioner can be actuated to (a) selectively move the probe along its own axis, (b) adjust the yaw angle of the right-angled probe tip, and (c) revolve the probe about the axis common to the positioner and casing. A cam plate engages a cam-follower portion of the probe and normally rotates with the positioner. The positioner includes a first-motor-driven ring gear which effects slidable movement of the probe by rotating the positioner at a time when an external pneumatic cylinder is actuated to engage the cam plate and hold it stationary. When the pneumatic cylinder is not actuated, this ring gear can be driven to revolve the positioner and thus the probe to a desired circumferential location about the above-mentioned common axis. A second motor-driven ring gear included in the positioner can be driven to rotate the probe about its axis, thus adjusting the yaw angle of the probe tip. The positioner can be used in highly corrosive atmosphere, such as gaseous uranium hexafluoride. 10 claims, 6 figures.

CENTRIFUGATION

9765 **Transformers for centrifuge motors designed for uranium enrichment.** Bagemiel, P.; Golde, E.; Maass, K. *Tech. Mitt. AEG-Telefunken;* **67**: No. 1, 30-34(1977). (In German).

4 figs.; 1 tab.; 3 refs.

Centrifuge installations for the separation of isotopes require vast power systems for the transformation and distribution of electrical energy. By means of a facility at the moment under construction in the Netherlands taken as an example, individual components such as high-voltage transformer, low-tension distribution, transformers, medium-frequency distribution and driving motors are presented. Because of its close coupling to the driving motors, a special conception has been developed for the transformer. Characteristics are explained in detail.

9766 **Effect of reflux in uranium enriching cascade.** Yamamoto, I.; Kanagawa, A. (Nagoya Univ. (Japan). Faculty of Engineering). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 12, 731-737(Dec 1976).

In uranium enriching cascades, the enrichment obtained on the product can be enhanced by introducing reflux from the product end to the feed stage. The effect of the reflux is analyzed on the basis of the solutions obtained of stagewise discrete flow equations. The degree of enhancement achieved on the enrichment is represented by the ratio of enrichments between the cases with and without reflux. If the enrichment is much smaller than unity, the ratio is constant throughout the cascade, and the value increases monotonously with the reflux rate, reaching its highest value when the reflux is total, to equal the ratio between the enrichment prevailing in the feed flow and that in the waste flow when devoid of reflux. Comparisons based on a model gas centrifuge cascade are made between three alternative expedients envisaged for enhancing the enrichment - (a) cascade feed flow control, (b) feed stage cut control, and (c) reflux rate control. Of these three expedients, (b) is found to bring about the highest enrichment with the least sacrifice of the separative work.

LASER EXCITATION

9767 **Method of separating isotopes.** Niemann, H.J. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,517,173/A/. 11 Nov 1976. 11p. (In German).

2 figs.

The invention is based on the excitation of a gaseous mixture of compounds of two isotopes by means of a laser beam with a spectral width corresponding at a maximum to the width of the isotope shift. The frequency is adjusted so as to determine the accumulation points of rotation vibration lines occurring in the absorption spectrum of a single isotope compound. The intensity of the radiation must be big enough so that its absorption in a pulsed laser reaches the saturation region. The radiation duration must then be smaller than the rotation relaxation time. A continuously radiating laser may also be used where a chemical or physical separating process is available which runs faster than the corresponding rotation relaxation time. Points of accumulation of rotation vibration lines in the infra-red, visible, and ultra-violet regions can be detected using fluorescence spectroscopy. The method, which may basically be applied to other isotope compounds, is illustrated by the example of UF_6 with its ^{235}U and ^{238}U isotope compounds.

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 9749, 9836, 9840

9768 (ORNL/TM—6087) **Influence of process variables on permeability and anisotropy of Biso-coated HTGR fuel particles.** Stinton, D.P.; Lackey, W.J.; Thiele, B.A. (Oak Ridge National Lab., Tenn. (USA)). Nov 1977. Contract W-7405-ENG-26. 22p. Dep. NTIS, PC A03/MF A01.

The effect of several important process variables on the fraction of defective particles and anisotropy of the low-temperature isotropic (LTI) coating layer was determined for Biso-coated HTGR fuel particles. Process variables considered are deposition temperature, hydrocarbon type, diluent type, and percent diluent. The effect of several other variables such as coating rate and density that depend on the process variables were also considered in this analysis. The fraction of defective particles was controlled by the dependent variables coating rate and LTI density. Coating rate was also the variable controlling the anisotropy of the LTI layer. Diluent type and diluent concentration had only a small influence on the deposition rate of the LTI layer. High-quality particles in terms of anisotropy and permeability can be produced by use of a porous plate gas distributor if the coating rate is between 3 and 5 μm/min and the coating density is between about 1.75 and 1.95 g/cm^3.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 9781, 9803, 9821, 9835, 9842

9769 (Juel—1372) **Process for separation of Pu and Np from aqueous solution of fissile and fertile material in a reprocessing of HTR-fuel elements.** Kankura, R. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Chemische Technologie; Technische Hochschule Aachen (Germany, F.R.)). Dec 1976. 135p. (In German). Dep. NTIS (US Sales Only), PC A07/MF A01.

Thesis.

The radiotoxicity of radioactive waste disposals of THTR-fuel elements will be fixed by the content of Pu and Np after 10^3 years for more than other 10^5 years. These two transuranium elements should therefore be separated from reprocessing products which are sent to a final disposal (fission products and Th e.g.). Several methods for the separation of Pu and Np by countercurrent extraction have been described in the literature. By this way, however, it was impossible to fall below concentrations of less than 5×10^{-8} Mol/l. The process described here separates Pu and Np below the detection limit of α-spectrometry ($< 4.1 \times 10^{-12}$ g Pu-238/ml, $< 10^{-7}$ g Np-237/ml) by combining a highly selective extraction system (trioctylamine (TOA) - 2 M HNO_3) with a chromatographic separation technique. As carrier material Voltalef 300 UFsub(R) - a polytrifluormonochlorethylene - was used. To use this process in a technical scale different limiting quantities were overhauled: influences of particle size, sieve fraction and loading with organic phase, flow velocity, column diameter, packing height and temperature range were investigated, different packing and elution techniques tested. The solvent loss and the effect of the irradiation-degradation on the organic substances were determined. On the basis of the results a separation apparatus was built and tested whereby the product solutions which are expected in the course of operation of the JUPITER-Pilot Plant for Thorium Element Reprocessing in the Kernforschungsanlage Juelich can be decontaminated from Pu and Np.

9770 (KFK—2416, pp 112-126) **Reprocessing of spent fuels from fast breeder reactors.** Ochsenfeld, W.; Baumgaertner, F.; Schmieder, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Heisse Chemie). 1976. (In German).

From KTG technical day on fuel element of the sodium-cooled breeder; Karlsruhe, F.R. Germany (28 Oct 1976).

In Fuel element of the LMFBR.

A survey is presented of experiments and results concerning the reprocessing of FBR spent fuels. Dealt with are fuel solvency, coextraction and separation of Pu/U, extractive Pu-purification and concentration, criticality safety and radiolysis as well as problems still to be solved.

9771 **Perchloric acid dissolution of graphite and pyrolytic carbon.** Buzzelli, G.; Mosen, A.W. (General Atomic Co., San Diego, Calif. (USA)). *Talanta;* **24**: No. 6, 383-385(Jun 1977).

Three procedures are described for the wet oxidation, with perchloric acid, of nuclear graphite, pyrocarbon-coated fuel particles, and other carbonaceous materials used in high-temperature gas-cooled nuclear reactors (HTGRs). The first procedure is for dissolution of graphite and pyrolytic carbon, the second for dissolution of milligram quantities of HTGR fuel particles, and the last for dissolution of more easily oxidized carbonaceous materials such as charcoal. These procedures were developed primarily for the dissolution of irradiated materials before fission-product or burn-up analyses, but they are also used for dissolution of unirradiated materials.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 10099

MARKETING AND ECONOMICS

9772 **Nuclear fuel.** Nakano, H. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). *Karyoku Genshiryoku Hatsuden;* **27**: No. 10, 1017-1031(Oct 1976). (In Japanese).

It is expected that nuclear power generation will reach 49 million kW in 1985 and 129 million kW in 1995, and the nuclear fuel having to be supplied and processed will increase in proportion to these values. The technical problems concerning nuclear fuel are presented on the basis of the balance between the benefit for human beings and the burden on the human beings. Recently, especially the downstream of nuclear fuel attracts public attention. Enriched uranium as the raw material for light water reactor fuel is almost monopolized by the U.S., and the technical information has not been published for fear of the diversion to nuclear weapons. In this paper, the present situations of uranium enrichment, fuel fabrication, trans-

portation, reprocessing and waste disposal and the future problems are described according to the path of nuclear fuel cycle. The demand and supply of enriched uranium in Japan will be balanced up to about 1988, but afterwards, the supply must rely upon the early establishment of the domestic technology by centrifugal separation method. No problem remains in the fabrication of light water reactor fuel, but for the fabrication of mixed oxide fuel, the mechanization of the production facility and labor saving are necessary. The solution of the capital risk for the construction of the second reprocessing plant is the main problem. Japan must develop waste disposal techniques with all-out efforts.

WASTE MANAGEMENT

9773 (UCRL—13764) **Performance criteria for solidified high-level radioactive wastes. Environmental impact statement. Revision 1.** (Tera Corp., Berkeley, Calif. (USA)). Sep 1977. Contract W-7405-ENG-48. 253p. Dep. NTIS, PC A12/MF A01.

This draft Environmental Impact Statement on performance criteria for solidified high-level radioactive wastes (PCSHLW) covers: considerations for PCSHLW development, the proposed rulemaking, characteristics of the PCSHLW, environmental impacts of the proposed PCSHLW, alternatives to the PCSHLW criteria, and cost/benefit/risk evaluation. Five appendices are included to support the technical data required in the Environmental Impact Statement.

WASTE PROCESSING

9774 (BARC—859) **Krypton-85 enrichment by adsorption-desorption process.** Khan, A.A.; Deshingkar, D.S.; Ramarathinam, K. (Bhabha Atomic Research Centre, Bombay (India)). 1975. 10p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The use of activated charcoal columns in conjunction with cryogenic distillation system for concentration of krypton-85 in fuel reprocessing process off-gas stream is reported. Dynamic adsorption of krypton on activated charcoals and its subsequent desorption by applying vacuum were studied. The possible reduction in the quantity of carrier gas to be liquefied in the cryogenic system by utilizing this process has been discussed on the basis of results of laboratory evaluations. The possibility of elimination of air and oxygen to avoid explosion hazards associated with radiolytic formation and concentration of ozone has also been considered.

9775 (BNWL-CC—2028(Suppl.1)) **324 building safety analysis report supplement.** Dodd, A.O.; Wittenbrock, N.G. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 24 Jun 1977. Contract EY-76-C-06-1830. 63p. Dep. NTIS, PC A04/MF A01.

Process engineering designs, major equipment and plant facilities to be utilized in commercial nuclear waste preparation and vitrification in the 324 Radiochemical Engineering Building are reviewed with regard to accident potential and consequences. This Safety Analysis Report Supplement compares calculated environmental doses anticipated from the Commercial Nuclear Waste Vitrification Project (CNWVP) routine operations with the average doses from past waste management operations conducted at the Hanford Project and finds them to be significantly less. The calculated CNWVP environmental doses are found to be far below presently applicable ERDA standards and standards proposed by the EPA for nuclear power operations. (DLC)

9776 (GJT—3) **Phase II, Title I engineering assessment of inactive uranium mill tailings, Mexican Hat site, Mexican Hat, Utah.** (Ford, Bacon and Davis Utah, Inc., Salt Lake City (USA)). 31 Mar 1977. Contract EY-76-C-13-1658. 167p. Dep. NTIS, PC A08/MF A01.

An engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at the Mexican Hat millsite in Utah is presented. Topographic maps, data on core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals residing nearby, the investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions are presented. Radon gas release from the 2,200,000 tons of tailings on the site constitutes the most significant environmental impact. T he six alternative actions presented are directed towards restricting access to the site, returning the windblown tailings to the piles and stabilizing the piles with cover material, and consolidating the two piles into one pile and stabilizing it with cover material. Fencing around the site or the tailings and the decontamination of mill buildings is included in all options. Costs of the options range from $370,000 to $4,390,000.

9777 (GJT—4) **Phase II, Title I engineering assessment of inactive uranium mill tailings, Monument Valley site, Monument Valley, Arizona.** (Ford, Bacon and Davis Utah, Inc., Salt Lake City (USA)). 31 Mar 1977. Contract EY-76-C-13-1658. 173p. Dep. NTIS, PC A08/MF A01.

An engineering assessment was made of the problems resulting from the existence of radioactive uranium mill tailings at the Monument Valley millsite in Arizona. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals residing nearby, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the tailings on the site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The sparse population and relatively low radiation levels yield minimal immediate environmental impact; hence, the two alternative actions presented are directed towards restricting access to the site and returning the windblown tailings to the pile and stabilizing the pile. Both options include remedial action costs for offsite locations where tailings have been placed. Cost estimates for the two options are $585,000 and $1,165,000.

9778 (MLM—2451) **Tritium waste control project: October 1976—March 1977.** Anderson, H.F.; Kershner, C.J. (Mound Lab., Miamisburg, Ohio (USA)). 6 Oct 1977. Contract EY-76-C-04-0053. 29p. Dep. NTIS, PC A03/MF A01.

Catalytic Exchange Detritiation: A pilot-scale combined electrolysis catalytic exchange system was constructed. Tritiated Liquid Waste Decontamination (Molecular Excitation): The scavenger and irradiation cell apparatus was completed for the two-photon ISP system. The uv source (xenon flashlamp) was adapted to the photolysis cell. A problem with the optical parametric oscillator was traced to prelasing due to a degradation in isolator rejection, and the laser power supply is being modified. Fixation of Aqueous Tritiated Waste in Polymer Impregnated Concrete: An optimum weight percent of catalyst in the monomer of 0.5 percent and an oven curing temperature of 55°C were established. The ratio of monomer to concrete is under investigation. Radiation Chemistry Studies of Tritium Fixation Packages: Pressure increase and gas composition were measured over (1) tritiated water (1000 Ci/l) with and without cement-plaster fixation and (2) tritiated n-octane (1000 Ci/l) with and without vermiculite or absorbal fixation. The back reaction that limits pressure buildup over water was inhibited by the fixative. The pressure buildup over waste vacuum pump oils was much less than the "worst case" predicted. Management of High Specific Activity Tritiated Liquid Wastes: Drums of solidified liquid waste were inspected one year after assembly. Of the 96 drums, four had internal pressures of 10 psig in the polyethylene primary container. This gas was found to contain H_2 and N_2 in addition to the original Ar. In the study of tritium release from typical waste packages, a max release of 1 Ci occurred from a 90,000-Ci package, and the average daily fractional release from six packages is 2×10^{-6}. Pressure tests were performed on both the components and the assembled package. The primary container can withstand a minimum of 30 psig internal pressure and 40 psig when contained in the secondary steel drum. 20 figures, 2 tables.

9779 (ORNL/NUREG/TM—7) **Correlation of radioactive waste treatment costs and the environmental impact of waste effluents in the nuclear fuel cycle: conversion of yellow cake to uranium hexafluoride. Part I. The fluorination-fractionation process.** Sears, M.B.; Blanco, R.E.; Finney, B.C.; Hill, G.S.; Moore, R.E.; Witherspoon, J.P. (Oak Ridge National Lab., Tenn. (USA)). Jul 1977. Contract W-7405-ENG-26. 332p. Dep. NTIS, PC A15/MF A01.

A cost/benefit study was made to determine the cost and effectiveness of radioactive waste (radwaste) treatment systems for decreasing the release of radioactive materials and chemicals from a model uranium hexafluoride (UF_6) production plant using the fluorination-fractionation (dry hydrofluor) process, and to evaluate the radiological impact (dose commitment) of the released materials on the environment. This study is designed to assist in defining the term as low as is reasonably achievable (ALARA) in relation to limiting the release of radioactive materials from nuclear facilities. The model plant processes 10,000 metric tons of uranium per year. Base-case waste treatment is the minimum necessary to operate the process. Effluents meet the radiological requirements listed in the Code of Federal Regulations, Title 10, Part 20 (10 CFR 20), Appendix B, Table II, but may not be acceptable chemically at all sites. Additional radwaste treatment techniques are applied to the base-case plant in a series of case studies to decrease the amounts of radioactive materials released and to reduce the radiological dose commitment to the population in the surrounding area. The costs for the added waste treatment operations and the corresponding dose commitment are calculated for each case. In the final analysis, radiological dose is plotted vs the annual cost for treatment of the radwastes. The status of the radwaste treatment methods used in the case studies is discussed. Much of the technology used in the advanced cases will require development and demonstration or else

is proprietary and unavailable for immediate use. The methodology and assumptions for the radiological doses are found in ORNL-4992.

9780 (ORNL/TM—5808) **Preliminary assessment of partitioning and transmutation as a radioactive waste management concept.** Croff, A.G.; Tedder, D.W.; Drago, J.P.; Blomeke, J.O.; Perona, J.J. (Oak Ridge National Lab., Tenn. (USA)). Sep 1977. Contract W-7405-ENG-26. 189p. Dep. NTIS, PC A09/MF A01.

Partitioning (separating) the actinide elements from nuclear fuel cycle wastes and transmuting (burning) them to fission products in power reactors represents a potentially advanced concept of radioactive waste management which could reduce the long-term (greater than 1000 years) risk associated with geologic isolation of wastes. The greatest uncertainties lie in the chemical separations technology needed to recover greater than 99 percent of the actinides during the reprocessing of spent fuels and their refabrication as fresh fuels or target elements. Preliminary integrated flowsheets based on modifications of the Purex process and supplementary treatment by oxalate precipitation and ion exchange indicate that losses of plutonium in reprocessing wastes might be reduced from about 2.0 percent to 0.1 percent, uranium losses from about 1.7 percent to 0.1 percent, neptunium losses from 100 percent to about 1.2 percent, and americium and curium from 100 percent to about 0.5 percent. Mixed oxide fuel fabrication losses may be reduced from about 0.5 percent to 0.06 percent for plutonium and from 0.5 percent to 0.04 percent for uranium. Americium losses would be about 5.5 percent for the reference system. Transmutation of the partitioned actinides at a rate of 5 to 7 percent per year is feasible in both fast and thermal reactors, but additional studies are needed to determine the most suitable strategy for recycling them to reactors and to assess the major impacts of implementing the concept on fuel cycle operations and costs. It is recommended that the ongoing program to evaluate the feasibility, impacts, costs, and incentives of implementing partitioning-transmutation be continued until a firm assessment of its potentialities can be made. At the present level of effort, achievement of this objective should be possible by 1980. 27 tables, 50 figures.

9781 (ORNL/TM—5825) **Theoretical analysis and preliminary experiments on the feasibility of removing CO_2 containing ^{14}C selectively with a $Ca(OH)_2$ slurry from a ^{85}Kr-contaminated HTGR reprocessing plant off-gas stream.** Forsberg, C.W. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 58p. Dep. NTIS, PC A04/MF A01.

Exploratory experiments were conducted to find methods of removing ^{14}C-contaminated CO_2 with a $Ca(OH)_2$ slurry from off-gas streams without removal of ^{85}Kr. Purging the product $CaCO_3$ slurry, created by reacting CO_2 and $Ca(OH)_2$, with a small amount of gas appears effective in the removal of any residual krypton from the $CaCO_3$. It therefore appears feasible to remove ^{14}C-contaminated CO_2 before removal of ^{85}Kr from HTGR off-gas streams and hence reduce the volume flow rate to the ^{85}Kr removal equipment with significant cost savings.

9782 Process for converting sodium nitrate-containing, caustic liquid radioactive wastes to solid insoluble products. Barney, G.S.; Brownell, L.E. (to Energy Research and Development Administration). US Patent 4,028,265. 7 Jun 1977. Filed date 25 Aug 1975. 12p.
PAT-APPL-607,853.

A method for solidifying sodium nitrate-containing, caustic, radioactive wastes comprises the steps of reacting powdered aluminum silicate clay, with the wastes which have a caustic concentration of about 3 to 7 M at 30 to 100°C to entrap the dissolved radioactive salts in the aluminosilicate matrix. In one embodiment, neutralized Purex-type waste, or salts or oxide produced by evaporation or calcination of these liquid wastes is converted to a formcancrinite having a composition $2(NaAlSiO_4)$. xSalt . y H_2O with x = 0.52 and y = 0.68 when the entrapped salt is $NaNO_3$. In another embodiment, the liquid is reacted with the powdered aluminum silicate clay, the resulting reaction product is air dried either as loose powder or molded shapes (e.g., bricks) and then fired at a temperature of at least 600°C to form the solid mineral nepheline. The leach rate of the entrapped radioactive salts with distilled water is reduced essentially to that of the aluminosilicate lattice which is very low, e.g., in the range of 10^{-2} to 10^{-4} g/cm²/day for cancrinite and 10^{-3} to 10^{-5} g/cm²/day for nepheline. 7 claims. (DLC)

9783 Management of radioactive waste at Point Lepreau generating station. Alikhan, S. (New Brunswick Electric Power Commission, NBEPC, Canada). *Nucl. Eng. Int.;* **22**: No. 258, 59-61(Jun 1977).

Waste management practice at Point Lepreau nuclear station is described. Only gaseous and liquid wastes will be released to the environment, consistent with regulatory requirements. Solid waste is packaged and stored in engineered structures at the Radioactive Waste Management Facility, the location and general arrangement of which are illustrated. Figures are quoted for the volume and estimated activity for the different types and sources of waste.

9784 Recovery of transplutonium elements from nuclear reactor waste. Campbell, D.O.; Buxton, S.R. (to Energy Research and Development Administration). US Patent 4,025,602. 24 May 1977. Filed date 25 May 1976. 10p.
PAT-APPL-689,888.

A method of separating actinide values from nitric acid waste solutions resulting from reprocessing of irradiated nuclear fuels comprises oxalate precipitation of the major portion of actinide and lanthanide values to provide a trivalent fraction suitable for subsequent actinide/lanthanide partition, exchange of actinide and lanthanide values in the supernate onto a suitable cation exchange resin to provide an intermediate-lived raffinate waste stream substantially free of actinides, and elution of the actinide values from the exchange resin. The eluate is then used to dissolve the trivalent oxalate fraction prior to actinide/lanthanide partition or may be combined with the reprocessing waste stream and recycled. 5 claims, 2 figures.

9785 Conversion of radioactive ferrocyanide compounds to immobile glasses. Schulz, W.W.; Dressen, A.L. (to Energy Research and Development Administration). US Patent 4,020,004. 26 Apr 1977. Filed date 21 Nov 1975. 6p.
PAT-APPL-634,224.

Complex radioactive ferrocyanide compounds result from the scavenging of cesium from waste products produced in the chemical reprocessing of nuclear fuel. These ferrocyanides, in accordance with this process, are converted to an immobile glass, resistant to leaching by water, by fusion together with sodium carbonate and a mixture of (a) basalt and boron trioxide (B_2O_3) or (b) silica (SiO_2) and lime (CaO). 7 claims.

9786 Fixation of tritium in a highly stable polymer form. Steinberg, M.; Colombo, P.; Pruzansky, J. (to Energy Research and Development Administration). US Patent 4,020,003. 26 Apr 1977. Filed date 24 Feb 1976. 4p.
PAT-APPL-660,909.

A method for the fixation of tritium comprises reacting tritiated water with calcium carbide to produce calcium hydroxide and tritiated acetylene, polymerizing the acetylene, and then incorporating the polymer in a solidifying matrix. 2 claims.

9787 Immobilization of iodine in concrete. Clark, W.E.; Thompson, C.T. (to Energy Research and Development Administration). US Patent 4,017,417. 12 Apr 1977. Filed date 30 Jul 1976. 8p.
PAT-APPL-710,087.

A method for immobilizing fission product radioactive iodine recovered from irradiated nuclear fuel comprises combining material comprising water, Portland cement and about 3 to 20 wt percent iodine as $Ba(IO_3)_2$ to provide a fluid mixture and allowing the fluid mixture to harden, said $Ba(IO_3)_2$ comprising said radioactive iodine. An article for solid waste disposal comprises concrete prepared by this method. 10 claims, 2 figures.

9788 Fluidized-bed calciner with combustion nozzle and shroud. Wielang, J.A.; Palmer, W.B.; Kerr, W.B. (to Energy Research and Development Administration). US Patent 4,017,253. 12 Apr 1977. Filed date 16 Sep 1975. 6p.
PAT-APPL-613,779.

A nozzle employed as a burner within a fluidized bed is coaxially enclosed within a tubular shroud that extends beyond the nozzle length into the fluidized bed. The open-ended shroud portion beyond the nozzle end provides an antechamber for mixture and combustion of atomized fuel with an oxygen-containing gas. The arrangement provides improved combustion efficiency and excludes bed particles from the high-velocity, high-temperature portions of the flame to reduce particle attrition. 4 claims, 2 figures.

9789 New possibilities of fabricating fission product bearing glasses and glas ceramics. Heimerl, W. (Gelsenberg A.G., Essen (Germany, F.R.)); Schiewer, E. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.). Bereich Kernchemie und Reaktor). *Atomwirtsch., Atomtech.;* **22**: No. 4, 223-224(Apr 1977). (In German).

The article discusses ceramic furnaces with direct electrical heating and the possibility to thus produce higher-melting glasses or glass ceramics which may be used as fixation materials for fission products.

9790 Experiences in the treatment of radioactive wastes. Krause, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). *Kerntechnik;* **19**: No. 4, 171-179(Apr 1977). (In German).

Low and medium level wastes have been routinely treated for many years at the technical scale with good success and processed to products safe for final storage so that inadmissible contamination of the environment whatsoever has not occurred. In the majority of cases the maximum permissible values were not reached by far. The treatment of highly active and α-wastes has not yet been demonstrated at the technical scale because these accumulate to a larger extent only in a further developed nuclear technology. The methods developed for this have proved their feasibility and reached such a degree

of maturity that it can be assumed that they will be available to the extent and at the time given by the general development of nuclear technology.

9791 Treatment and disposal of radioactive wastes. Krause, H.; Starch, M. *VDI (Ver. Dtsch. Ing.) Z.;* **119**: No. 8, 430-433(Apr 1977). (In German).

Out of an abundance of contributions on this subject published during the last 2 years, only the most important new developments are dealt with here. All over the world known methods have been improved, new ones developed especially in the field of solidifying highly active liquid wastes. For general information, surveys and conference proceedings are listed as well.

9792 Some studies on the treatment of medium active waste. Ghattas, N.K. (Atomic Energy Authority, Cairo (Egypt). Radioisotope Dept.). *J. Radioanal. Chem.;* **35**: No. 2, 269-279(1977).

An attempt is made to select the most convenient method of chemical treatment as an interim process prior to evaporation depending on the results of both α- and γ-spectrometric analysis of the waste solution under consideration. The use of titanium hydroxide-cobalt ferrocyanide as coprecipitant allows fixation of high percentage of radioactive nuclides present (Cs 98%, Ru 90%, Sb 95%, Ce 98%, Am 95% and Pu 95%). Hence using such simple chemical separation before evaporation improves the process and leads to several advantages, e.g. raising the decontamination factor, reducing radioactive aerosol production and solving the problem of medium active waste treatment by adding the chemically precipitated solids to the high-active waste and the supernatant to the low-active waste.

9793 Trend on management of radioactive wastes in Japan. Miki, Y. (Science and Technology Agency, Tokyo (Japan). Nuclear Safety Bureau). *Genshiryoku Kogyo;* **22**: No. 9, 22-26, 32(Sep 1976). (In Japanese).

In the nuclear fuel cycle for power generation, low-level wastes appear in large quantities from nuclear power plants, and low-level wastes and small quantity of high-level wastes emerge from fuel reprocessing facilities. The governmental policy on the treatment and disposal of radioactive wastes is described on the basis of an interim report in this respect by the Japan AEC. After solidification, high-level wastes must be isolated entirely from human environment. For low-level wastes, solidification mainly with cement is applied. As far as possible, such packages are disposed of in the sea; and disposal on land will be supplementary to it.

9794 Radioactive waste disposal for liquid scintillators. Kiho, Y. (Institute for Plant Virus Research, Chiba (Japan)). *Radioisotopes (Tokyo);* **25**: No. 8, 474-480(Aug 1976). (In Japanese).

Attempts are made to treat organic scintillation liquid wastes containing radioactive molecules (labelled with ^{3}H, ^{14}C, or ^{32}P). The radioactive molecules in such fluids are difficult to catch on adsorbents, probably because they are dissolved or emulsified into organic solvents by complex means. By addition of saline to the scintillation fluid, a white creamy sol is formed. The emulsion thus made is destroyed by warming. After standing, two layers are clearly separated. The upper layer is mainly a nonpolar organic solvent holding hydrophobic molecules, and the lower layer is mainly water containing hydrophilic molecules. The two layers can then be treated separately with charcoal to adsorb radioactive molecules easily. Tritium water (HTO) can be transferred from the organic scintillation fluid (monophase) into the water layer. The latter can be used repeatedly for the treatment of fresh monophase. Thus the HTO in a large amount of monophase can be concentrated into a small volume of water layer.

9795 Processing of radioactive gases in waste gases in a ventilation system in an atomic power plant. Yuasa, Y.; Ota, M.; Watanabe, A.; Taruishi, Y. (to Nippon Atomic Industry Group Co. Ltd., Tokyo). Japanese Patent 1976-138298/A/. 27 May 1975. 4p. (In Japanese).

A method is claimed to effectively attenuate low density radioactive rare gases and radioactive iodine contained in waste gases in a large airflow ventilation system to purify the waste gases before discharging into atmosphere. In discharging large airflow waste gases in a ventilation system in an atomic power plant through a chimney, the aforesaid waste gases are introduced into a liquefaction and distilling apparatus to separate into nitrogen and oxygen, which occupy a greater part thereof, and small quantities of oxygen or the like containing enriched rare gases and iodine, the former being discharged through the chimney directly, while the latter is sent to a delay device to attenuate the radioactivity before the discharge thereof through the chimney.

9796 Apparatus for processing radioactive liquid wastes. Irie, H.; Tajima, F.; Kuribayashi, N.; Isozaki, K. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-138300/A/. 26 May 1975. 4p. (In Japanese).

A method is provided to prevent a vapor heater system of an evaporation and enrichment unit from being contaminated by radioactivity. A radioactive liquid waste discharging line is provided through a sluice valve in a heated vapor pipeline of a vapor heater in a radioactive liquid waste evaporation and enrichment apparatus.

9797 Method of start-up operation of a liquefaction and distillation apparatus for processing waste gases containing radioactive rare gases. Ota, M.; Tani, A.; Hashimoto, H.; An, B.; Kanazawa, T. (to Nippon Atomic Industry Group Co. Ltd., Tokyo). Japanese Patent 1976-133694/A/. 15 May 1975. 3p. (In Japanese).

A method is claimed to enable reduction of cooling time, simplification of maintenance, and release of cooling gas outside system. In starting of the liquefaction and distillation apparatus, liquid nitrogen is introduced into the tower bottom of a rectification tower from a liquid nitrogen tank through a liquid nitrogen supply line to vaporize the liquid nitrogen with help of heat entered from outside and a heater. The vaporized nitrogen gas moves up while cooling the interior of the rectification tower and is guided by a vacuum pump from the top of tower toward the purifying gas line and low temperature heat exchanger and disharging into atmosphere. When the interior of the apparatus is sufficiently cooled in a manner as described above, the liquid nitrogen supply line is closed, the liquid nitrogen is fed to a condenser, and the waste gases containing the radioactive rare gases from the raw exhaust supply line are introduced into the rectification tower for entry of normal operation.

9798 Method for storing radioactive rare gases. Watabe, A.; Nagao, H.; Takiguchi, Y.; Kanazawa, T.; Soya, M. (to Nippon Atomic Industry Group Co. Ltd., Tokyo). Japanese Patent 1976-133698/A/. 15 May 1975. 4p. (In Japanese).

A method is claimed to safely and securely store radioactive rare gases for a long period of time. The waste gases produced in nuclear power plant are cooled by a cooler and then introduced into a low temperature adsorbing device so that the gases are adsorbed by adsorbents, and then discharged into atmosphere through the purifying gas discharge line. When the radioactive rare gases reach a level of saturation in the amount of adsorption, they are heated and extracted by a suction pump and heated by a heater. The gases are then introduced into an oxygen-impurity removing device and the purified rare gases containing no oxygen and impurities are cooled by a cooler and fed into a gas holder. When the amount of radioactive rare gases stored within the gas holder reaches a given level, they are compressed and sealed by a compressure into a storing cylinder and residual gases in the piping are sucked and recovered into the gas holder, after which the cylinder is removed and stored in a fixed room.

9799 Method for reduced the producing amount of ozone within a liquefaction and distillation apparatus for processing radioactive dilute gas containing gases and liquefaction and distillation apparatus for embodying thereof. Yuasa, Y.; Nagao, H.; Takiguchi, Y.; An, B.; Kanazawa, T. (to Nippon Atomic Industry Group Co. Ltd., Tokyo). Japanese Patent 1976-133693/A/. 15 May 1975. 4p. (In Japanese).

A method is claimed to reduce the producing amount of ozone within a liquefaction and distillation apparatus for processing radioactive dilute gas. The radioactive dilute gas containing gases are supplied to a rectification tower through a heat exchanger. Oxygen and nitrogen are cooled by a condenser cooled with liquid nitrogen, and they are partly condensed into a circulating liquid, the remainder being released into atmosphere through a purifying gas line. The radioactive dilute gas is taken out of the tower bottom through a liquid taking-out line and heated by a heater, after which ozone is removed by an ozone remover unit, finally meeting the raw gases. The tower bottom is filled with filler such as Raschig ring to absorb radioactive energy and thus prevent generation of ozone within the tower.

9800 Process for treating waste gases from a reactor equipment. Yuasa, Y.; Tani, A.; Hashimoto, H.; An, B.; Tsuda, K. (to Nippon Atomic Industry Group Co. Ltd., Tokyo). Japanese Patent 1976-133695/A/. 15 May 1975. 4p. (In Japanese).

A method is claimed to prevent discharge of waste gases having a high radioactivity density into atmosphere at the time of failure or damages of machineries, piping and seals in valves or the like. Hydrogen and stream contained in waste gases from a turbine condenser are removed by a re-coupler unit, cooler and water-gas separator, and radioactive substances are attenuated and removed by a delay pipe and filter, after which water and carbon dioxide gas are removed by a water-carbon dioxide gas remover unit and cooled by a heat exchanger, and thereafter introduced into a rectification tower. A vacuum pump is installed on the purifying gas line at the outlet of the heat exchanger, whereby process for adsorbing and removing water and carbon dioxide gas and process for rectifying and separating the radioactive rare gas are accomplished under negative pressures. A heater is installed on the liquid taking-out line from the bottom of the rectification tower to heat and vaporize the taken out liquid by means of a heater, after which the liquid is returned to inlet of an air extractor and the impurities are removed by the re-coupler.

9801 **Process for treating radioactive waste gases.** Yuasa, Y.; Nagao, Hiroyuki; Takiguchi, Y.; An, B.; Tsuda, K. (to Nippon Atomic Industry Group Co. Ltd., Tokyo). Japanese Patent 1976-133696/A/. 15 May 1975. 4p. (In Japanese).

A method is claimed to securely perform separation and enrichment of radioactive rare gases to store them safely for a long period of time. The wastes extracted by an air extractor are processed by a heater and a recombiner and hydrogen and oxygen are changed into water thereby and it is passed through a gas and water separator to be dewatered, after which water and carbon dioxide gas are removed by passing through a delay pipe, filter, and water and carbon dioxide gas removing device and then fed to a lower temperature adsorbing device to adsorb and remove the radioactive rare gases. This low temperature adsorbing device is composed of two towers, one of which is designed to saturate the radioactive rare gases, which are processed by a heater and passed through a recycle line to meet raw gases. Then, it is fed to the other lower temperature adsorbing device and this cycle is repeated to enrich the radioactive rare gases. Oxygen and impurities in the enriched gases are removed by the impurity removing device and thereafter are stored in a gas holder and finally sealed in a cylinder.

9802 **Method of treating the waste liquid of a washing containing a radioactive substance.** Sawaguchi, Y.; Tsuyuki, T.; Kaneko, M.; Sato, Y.; Yamaguchi, T. (to Tokyo Electric Power Co., Inc. (Japan)). Japanese Patent 1976-124800/A/. 24 Apr 1975. 4p. (In Japanese).

A method is claimed to separate waste liquid resulting from washing and which contains a radioactive substance and surface active agent into high purity water and a solid waste substance containing a small quantity of surface active agent. To waste liquid from a waste liquid tank is added a pH adjusting agent for adjusting the pH to 5.5, and the resultant liquid is sent to an agglomeration reaction tank, in which an inorganic agglomerating agent is added to the waste liquid to cause a major proportion of the radioactive substance and surface active agent to form flocks produced through agglomeration. Then, the waste liquid is sent from the agglomeration reaction tank to a froth separation tank, to which air is supplied through a perforated plate to cause frothing. The over-flowing liquid is de-frothed, and then the insoluble matter is separated as sludge, followed by hydroextraction and drying for solidification. The treated liquid extracted from a froth separation tank is sent to an agglomerating agent recovery tank for separation of the agglomeration agent, and then the residual surface active agent is removed by adsorption in an active carbon adsorption tower, followed by concentration by evaporation in an evaporating can. The concentrated liquid is extracted and then solidified with cement or asphalt.

9803 **System for separating radioactive krypton gas.** Kimura, S.; Awada, Y. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-124799/A/. 23 Apr 1975. 3p. (In Japanese).

A system for separating radioactive krypton gas in a nuclear fuel reprocessing exhaust gas through liqueliquefaction is claimed. The system permits ready and economical operation and recovery of liquefied nitrogen as a cooling source. In a liquifaction distillation system, two material gas heat exchangers are provided in parallel in front of a previous stage distillation tower for removing impurities (such as CO_2, NOsub(X) and O_2). Then, distillation by evaporation is effected in two stages through two distillation towers provided in series for facilitating the operation. Of the two distillation towers the first one is provided with means for recovering through liquefaction evaporated liquid nitrogen gas constituting a cooling source.

9804 **Method of separating radioactive krypton gas.** Kimura, S.; Awada, Y. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-121700/A/. 18 Apr 1975. 4p. (In Japanese).

A method is provided to effectively and safely separate and recover Kr-85, which requires a long storage period for attenuating radioactivity, from a mixture gas consisting of Kr-85 and Xe by a liquefaction distillation method. A gas mixture consisting of Kr and Xe is subjected to heat exchange in a cooler with Freon gas from a plurality of distillation towers for its temperature reduction from normal temperature to a lower temperature, and then it is supplied to a distillation tower. The distillation tower is held at a pressure above 15 ata, preferably around 20 ata, and a condenser provided at the top of the distillation tower is furnished with Freon as cooling medium. The rare gas mixture is distilled by liquefaction within a distillation tower, and Kr-85 is obtained from a top duct while obtaining Xenon from a bottom duct. Xe after separation by liquefaction is returned to a rare mixture gas supply inlet of a liquefaction distillation means for repeated refinement in the distillation tower.

9805 **Vaporizer for radioactive wastes.** Takahara, T. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-119499/A/. 10 Apr 1975. 3p. (In Japanese).

A method is claimed to set a liquid level of a liquid feed pot disposed adjacent to a vaporizer to a mounting position of an overflow tube thereby maintaining a constant liquid level in the vaporizer. A small capacity liquid feed pot is positioned at a height of water level to be controlled in the neighbourhood of a vaporizing closed cylindrical vessel. The liquid feed pot has its bottom communicated with the bottom of the closed cylindrical vessel through a communicating pipe. Waste liquid collected into the liquid feed tank is supplied by a pump to the liquid feed pot. The waste liquid equal in amount to that vaporized in the closed cylindrical vessel is supplied from the liquid feed pot to the closed cylindrical vessel to maintain its water level, whereas extra waste liquid is circulated from the overflow pipe mounted at the upper part of the liquid feed pot to the liquid feed tank.

9806 **Concentration of radioactive liquid wastes.** Ojima, A. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-117299/A/. 7 Apr 1975. 3p. (In Japanese).

A method is claimed to make direct contact of vapor with liquid to thereby concentrate radioactive waste liquids without using a heating tube. A given amount of raw liquids to be concentrated is introduced from a pipe to a vessel, and vapor is added thereto from a starting vapor pipe to effect heat exchanging by means of direct contact, thus heating the raw liquids. After the raw liquids reach a saturation temperature within the vessel resulting from heating thereof, the liquid is partly vaporized and extracted from a vaporizing pipe. This vapor is sent to a compressor through a vapor branch pipe and compressed there at and then circulated into the condenser through a heating vapor pipe. When the quantity of vaporized vapor is sufficiently produced, the starting vapor is stopped to extract a part of the produced vapor outside the system through the vapor pipe. The energy required for vaporization after the aforesaid state is established is imparted by the compressor and heater. The condensed liquid obtained as a result of operation for a given period of time is discharged through a discharge pipe.

9807 **Solidification process of radioactive wastes.** Otaka, H.; Tamura, K. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-111600/A/. 28 Mar 1975. 3p. (In Japanese).

A method is claimed to obtain safe and economical treatment by using floor drain condensed waste liquid for cementation of solid waste material. Solid waste material (waste resin and waste sludge) is dehydrated by a dehydrator, measured by a hopper and then charged into a drum can. Then, cement within the hopper is charged through a valve into the drum can while agitating the solid waste material within the drum can, and at the same time the floor drain condensed waste liquid within the storage tank is supplied through a pump into a measuring tank for measurement therein and then charged into the drum can. The resultant system is then mixed well and solidified. This drum can is stored in a storeroom. Meanwhile, the regenerated waste liquid is transferred from the condenser to the storage tank and then supplied from the pump to the measuring tank for measurement and then similarly charged into the drum can for mixing with the cement and solidification.

9808 (ORNL-tr—4417) **Latest research and advances in the treatment of low- and intermediate-level radioactive wastes in Bulgaria, Hungary, the USSR and Czechoslovakia.** Balukova, V.D.; Kulichenko, V.V.; Nazarov, A.I.; Sibirev, A.V.; Rauzen, F.V. (Oak Ridge National Lab., Tenn. (USA)). Dec 1965. Translated from the Russian, practices in the treatment of low- and intermediate level radioactive wastes. (CONF-651202—47). 29p. Dep. NTIS, PC A03/MF A01.

From Symposium on practices in the treatment of low and intermediate level radioactive waste; Vienna, Austria (6 Dec 1965).

The authors supply data on waste water coagulation and detergent decontamination. They report the results of investigations into ion-exchange methods of decontamination, extradialysis and concentration by evaporation. Data are given for various methods of solidifying radioactive wastes, e.g., vitrification, cementing and the preparation of ceramic blocks. The authors also discuss data resulting from the incineration of wastes in experimental furnaces. They include a short account of waste treatment work in Bulgaria, Hungary and Czechoslovakia.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 9783, 9793, 9834

9809 (UCRL—52304) **Compressible fluid flow through rocks of variable permeability.** Lin, W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Jul 1977. Contract W-7405-ENG-48. 19p. Dep. NTIS, PC A02/MF A01.

The effectiveness of course-grained igneous rocks as shelters for burying radioactive waste can be assessed by determining the rock permeabilities at their in situ pressures and stresses. Analytical and numerical methods were used to solve differential equations of one-dimensional fluid flow through rocks with permeabilities from 10^4 to 1 nD. In these calculations, upstream and downstream reservoir volumes of 5, 50, and 500 cm^3 were used. The optimal size combinations of the two reservoirs were determined for measure-

ments of permeability, stress, strain, acoustic velocity, and electrical conductivity on low-porosity, coarse-grained igneous rocks.

9810 (Y/OWI/SUB—77/16535/5) **National Waste Terminal Storage Program Information Management Plan. Volume I. Management summary.** (Union Carbide Corp., Oak Ridge, Tenn. (USA). Office of Waste Isolation). May 1977. Contract W-7405-ENG-26. 12p. Dep. NTIS, PC A02/MF A01.

A comprehensive information management plan is needed for the processing of the large amount of documentation that will accumulate in the National Waste Terminal Storage program over the next decade. The plan will apply to all documentation from OWI contractors, subcontractors, and suppliers, and to external documentation from OWI organizations. (DLC)

9811 (Y/OWI/TM—18/3) **Summary of geologic review group meetings, July 21—22, 1977.** Frye, J.C; Crawford, J.H.; Davis, S.N.; Donath, F.A.; Gloyna, E.F.; Krauskopf, K.B. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Office of Waste Isolation). 1977. Contract W-7405-ENG-26. 11p. Dep. NTIS, PC A02/MF A01.

After the GRG heard data and progress reports on the WIPP program at the meeting, the group made suggestions and recommendations, including site criteria for a radioactive waste repository. (DLC)

9812 **Method for the safe disposal of alkali metal.** Johnson, T.R. (to Energy Research and Development Administration). US Patent 4,032,615. 28 Jun 1977. Filed date 27 Jan 1976. 6p.

PAT-APPL-651,981.

Alkali metals such as those employed in liquid metal coolant systems can be safely reacted to form hydroxides by first dissolving the alkali metal in relatively inert metals such as lead or bismuth. The alloy thus formed is contacted with a molten salt including the alkali metal hydroxide and possibly the alkali metal carbonate in the presence of oxygen. This oxidizes the alkali metal to an oxide which is soluble within the molten salt. The salt is separated and contacted with steam or steam—CO_2 mixture to convert the alkali metal oxide to the hydroxide. These reactions can be conducted with minimal hydrogen evolution and with the heat of reaction distributed between the several reaction steps. 5 claims, 1 figure.

9813 **Process for the disposal of alkali metals.** Lewis, L.C. (to Energy Research and Development Administration). US Patent 4,032,614. 28 Jun 1977. Filed date 20 Oct 1975. 4p.

PAT-APPL-624,030.

Large quantities of alkali metals may be safely reacted for ultimate disposal by contact with a hot concentrated caustic solution. The alkali metals react with water in the caustic solution in a controlled reaction while steam dilutes the hydrogen formed by the reaction to a safe level. 6 claims.

9814 **Waste canister for storage of nuclear wastes.** Duffy, J.B. (to Energy Research and Development Administration). US Patent 4,021,676. 3 May 1977. Filed date 7 May 1976. 4p.

PAT-APPL-684,421.

A waste canister for storage of nuclear wastes in the form of a solidified glass includes fins supported from the center with the tips of the fins spaced away from the wall to conduct heat away from the center without producing unacceptable hot spots in the canister wall. 4 claims, 4 figures.

9815 **Leaching behavior of ^{60}Co in cement composites.** Matsuzuru, H.; Moriyama, N.; Wadachi, Y.; Ito, A. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Health Physics and Safety Div.). *Atomkernenergie;* **29**: No. 4, 287-289(1977).

The leaching of ^{60}Co into a surrounding fluid from a cement waste composite has been studied for safety assessment of the final disposal of wastes. Leaching tests were made by the batch method recommended by IAEA. Leaching fractions were measured as functions of the waste to cement (Wa/C) ratio, salt content of waste, temperature of leachant and curing time of specimens. The leaching behavior of Co 60 does not depend much on Wa/C ratio and salt content of waste. The leaching fraction decreases with decrease of the leachant temperature and increase of the curing duration. The portland cement composite gives a lower leachability than that of the slag cement.

9816 **Experimental study on the properties of drum-packed, cement solidified waste package of pre and after sea dumping test of sea depth 30m and 100m.** Maki, Y.; Abe, H.; Hattori, S. (Central Research Inst. of Electric Power Industry, Tokyo (Japan)). *Denshi Gijutsu Sogo Kenkyusho Chosa Hokoku;* No. 74019, 1-4, 1-18(Mar 1976). (In Japanese).

Japan Marine Science and Technology Center has been tackling with the development of the monitoring system to confirm the soundness of drum-packed, cement-solidified low level radioactive waste (the package) during falling and after reaching at sea bed when it is dumped into sea. The test was carried out at Sagami Bay of 30 m and 100 m sea depth using non-radioactive packages. The observation of the falling behavior of packages in sea was carried out by taking photographs of the motion of packages with an underwater 16 mm movie camera and an underwater industrial TV (ITV), and the observation of the soundness and the area of packages scattered on sea bed was carried out with an underwater ITV and an underwater 70 mm snap camera which were set up on the frame. The proportion of cement-solidified waste was decided so that the uniaxial compressive strength of the cement-solidified waste satisfies the condition of "The tentative guideline". Prior to tests at sea, hydrostatic pressure test of packages are carried out on land. After that, core specimens were sampled to obtain the uniaxial compressive strength from packages and were tested. After sea dumping tests, 6 packages were recovered from sea bed, and the soundness were tested. As the results, the deformation and damage of drums and cement solidified waste packages did not occur at all.

9817 **Characterization of actinide-bearing sediments underlying liquid waste disposal facilities at Hanford.** Price, S.M. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)); Ames, L.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). pp 191-210 of In Transuranium nuclides in the environment. Vienna; IAEA (1976).

From Symposium on transuranium nuclides in the environment; San Francisco, Calif., USA (17 - 21 Nov 1975).

Past liquid waste disposal practices at the US Energy Research and Development Administration's Hanford Reservation have included the discharges of solutions containing low concentrations of actinides directly into the ground via structures collectively termed "trenches". Characterization of samples from two of these trenches, the 216-Z-9 and the 216-Z-1A(a), has been initiated to determine the present form and migration potential of plutonium stored in sediments which received high salt, acidic waste liquids. Analysis of samples acquired by drilling has revealed that the greatest measured concentration of plutonium, approximately 10^6 $\mu Ci^{239}Pu/1$ of sediment, occurs in both facilities just below the points of release of the waste liquids. This concentration decreases to approximately 10^3 $\mu Ci^{239}Pu/1$ of sediment within the first 2 m of the underlying sediment columns and to approximately 10 $\mu Ci^{239}Pu/1$ of sediment at the maximum depth sampled (9m). Examination of relatively undisturbed sediment cores illustrated two types of Pu occurrence responsible for this distribution. One of these types is composed of Pu particles (>70 wt% PuO_2) added to the disposal site in the same form. This "particulate" type was "filtered out" within the upper 1 m of the sediment column, accounting for the high concentration of Pu/1 of sediment in this region. The second type of Pu (<0.5 wt% PuO_2) was originally disposed of as soluble Pu(IV). This "nonparticulate" type penetrated deeper within the sediment profile and was deposited in association with silicate hydrolysis of the sediment fragments.

9818 **Method of storing radioactive rare gas.** Nagao, H.; Miharada, H.; Takiguchi, Y.; Kanazawa, T.; Soya, M. (to Nippon Atomic Industry Group Co. Ltd., Tokyo). Japanese Patent 1976-133699/A/. 15 May 1975. 3p. (In Japanese).

A method is provided to prevent dispersion of radioactive rare gas atoms by sealing them in a pressurised state within zeolite and thereby confining them in position within the zeolite crystal lattice. Radioactive rare gas is separated from exhaust gas and concentrated by using a low temperature adsorption means or liquefaction distillation means and necessary accessory means, and then it is temporarily stored in a gas holder. When a predetermined quantity of storage is reached, the gas is led to a sealing tank containing zeolite heated to 300 to 400°C and held at 3,000 to 4,000 atmospheres, and under this condition radioactive rare gas is brought to occupy the spaces in the zeolite crystal lattice. After equilibrium pressure is reached by the pressure in the tank at that temperature, the gas is cooled in the pressurised state down to room temperature. Subsequently, the rare gas remaining in the tank and duct is recovered by a withdrawal pump into the gas holder. Thereafter, the zeolite with radioactive rare gas sealed in it is taken out from the tank and sealed within a long period storage container, which is then housed in a predetermined place for storage.

9819 **Method for storing radioactive rare gases.** Tani, A.; Miharada, H.; Hashimoto, H.; Kanazawa, T.; Soya, M. (to Nippon Atomic Industry Group Co. Ltd., Tokyo). Japanese Patent 1976-133697/A/. 15 May 1975. 3p. (In Japanese).

A method is claimed to lock radioactive rare gases as the surrounding compounds to thereby safely and securely store them for a long period of time. The radioactive rare gases separated from waste gases by the low temperature adsorbing device or the like are once stored in a gas holder and when they reach a given level of storage, they are introduced under pressure by a pressurizing machine into a reaction vessel containing hydroquinone aqueous solution and dissolved sufficiently. Then, the hydroquinone aqueous solution is gradually cooled by a temperature controller to room temperature to thereby separate the surrounding compound. Thereafter, the radioactive rare gases remained within the reaction vessel and piping are recovered into the gas holder by means of a suction

pump and then, the surrounding compound is separated from the solution and sealed into a storing container for a long period of time.

9820 Apparatus for treating radioactive vent gas. Takeshima, M.; Kishino, S. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-111599/A/. 28 Mar 1975. 3p. (In Japanese).

A method is claimed to reduce radioactivity contained in gaseous waste discharged from the chimney of an atomic power plant. An air sponger and liquid level gauge are provided within a radioactive waste liquid tank. Every time the waste liquid flows into said tank air is supplied from a blower through an on-off valve into a sponger to agitate the waste liquid. On the other hand, air is always supplied from a blower to said liquid level gauge. These air streams pass through the waste liquid and flow through a vent duct together with radioactive gas and mist. The vent gas is heated by a heater for reduction of the relative humidity and then led to an active carbon adsorption layer for removing radioactive gas through adsorption, and they are then withdrawn through a surge tank by a blower.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 9773, 9776, 9777, 9779, 10921, 10922, 10941, 11003, 11022, 11024

9821 (CONF-771008—5) **Radiological environmental assessment of the recycle of LMFBR advanced fuels.** Tennery, V.J.; Bomar, E.S.; Till, J.E.; Morse, L.E.; Pobereskin, M.; Madia, W.J. (Oak Ridge National Lab., Tenn. (USA); Battelle Columbus Labs., Ohio (USA)). 1977. Contract W-7405-ENG-26. 21p. Dep. NTIS, PC A02/MF A01.

From International meeting on advanced LMFBR fuels; Tucson, Arizona, USA (10 Oct 1977).

The environmental impact resulting from the release of radioactive material during reprocessing and refabrication of spent LMFBR advanced fuels was compared with that from similar treatment of reference oxide fuel. Candidate advanced fuels include carbide [(U,Pu)C] in addition to nitride [(U,Pu)N] with selected concentrations of ^{15}N. Several techniques for preparing enriched ^{15}N were reviewed and estimates were made of the cost of preparing nitrogen enriched to greater than 99 percent by each method. Core neutronics, fuel management, and designs appropriate for each fuel were used with the ORIGEN code to calculate the compositions of spent core and blanket fuel. The mass of fuel recycled annually was that providing 50 GW(e)-years of energy at the burnup attained by each fuel. Confinement factors for each isotope were identified for reprocessing and refabrication operations and were used to calculate source terms describing isotopic release rates. These source terms were used in the AIRDOS-II code to estimate the 50-year dose to the maximally exposed individual and to both the local and world populations. Total body dose commitments to the maximally exposed individual for oxide and carbide fuels are about 2.8 millirem, while nitride fuel would result in a range of 59 to 3.4 millirem as the ^{14}N content in fresh fuel is varied from 99.64 percent to zero.

9822 (GJT—2) **Engineering assessment of inactive uranium mill tailings, Shiprock site, Shiprock, New Mexico. Phase II, Title I.** (Ford, Bacon and Davis Utah, Inc., Salt Lake City (USA)). 31 Mar 1977. Contract EY-76-C-13-1658. 209p. Dep. NTIS, PC A10/MF A01.

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Shiprock, New Mexico. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the 1.7 million tons of tailings at the Shiprock site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The 11 alternative actions presented range from completion of the present ongoing EPA site decontamination plan (Option I), to stabilizing in-place with varying depths of cover material (Options II-IV), to removal to an isolated long-term disposal site (Options V-XI). All options include remedial action costs for off-site locations where tailings have been placed. Costs estimates for the 11 options range from $540,000 to $12,500,000. Reprocessing the tailings for uranium is not economically feasible.

9823 (GJT—3S) **Engineering assessment of inactive uranium mill tailings, Mexican Hat site, Mexican Hat, Utah. A summary of the Phase II, Title I.** (Ford, Bacon and Davis Utah, Inc., Salt Lake City (USA)). 31 Mar 1977. Contract EY-76-C-13-1658. 52p. Dep. NTIS, PC A04/MF A01.

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at the Mexican Hat millsite in Utah. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals residing nearby, the investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions. Radon gas release from the 2,200,000 tons of tailings on the site constitutes the most significant environmental impact. The six alternative actions presented are directed towards restricting access to the site (Option I), returning the windblown tailings to the piles and stabilizing the piles with cover material (Options II, III, and IV), and consolidating the two piles into one pile and stabilizing it with cover material (Options V and VI). Fencing around the site or the tailings and the decontamination of mill buildings is included in all options. Options II and V provide 2 ft of cover material on the tailings, Options III, IV, and VI provide 4 ft, 13 ft, and 10 ft of cover, respectively. Costs of the options range from $370,000 to $4,390,000. Reprocessing the tailings for uranium is not feasible at present.

9824 (GJT—4S) **Engineering assessment of inactive uranium mill tailings, Monument Valley site, Monument Valley, Arizona. A summary of the Phase II, Title I.** (Ford, Bacon and Davis Utah, Inc., Salt Lake City (USA)). 31 Mar 1977. Contract EY-76-C-13-1658. 50p. Dep. NTIS, PC A03/MF A01.

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at the Monument Valley millsite in Arizona. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals residing nearby, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the tailings on the site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The sparse population and relatively low radiation levels yield minimal immediate environmental impact; hence, the two alternative actions presented are directed towards restricting access to the site (Options I and II), and returning the windblown tailings to the pile and stabilizing the pile with 2 ft of cover material (Option II). Both options include remedial action costs for offsite locations where tailings have been placed. Cost estimates for the two options are $585,000 and $1,165,000. Reprocessing the tailings for uranium is not economically feasible.

9825 (GJT—5) **Engineering assessment of inactive uranium mill tailings, Tuba City site, Tuba City, Arizona. Phase II, Title I.** (Ford, Bacon and Davis Utah, Inc., Salt Lake City (USA)). 31 Mar 1977. Contract EY-76-C-13-1658. 175p. Dep. NTIS, PC A08/MF A01.

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at the Tuba City millsite in Arizona. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals residing nearby, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the tailings on the site constitutes the most significant environmental impact to the inhabited area near the site. In the downwind direction, to the northeast of the site, airborne radioactivity is greater than Federal guidelines but there are no dwellings in that direction in the area of concern. Gamma radiation is significant over the tailings but is near background levels in the housing area. The sparse population and relatively low radiation levels yield minimal immediate environmental impact; hence, the four alternative actions presented are directed towards restricting access to the site (Option I), and returning the windblown tailings to the pile and stabilizing the pile with cover material (Options II, III, and IV). Fencing around the site or the tailings pile and the removal or decontamination of mill buildings is included in all options. Option II provides 2 ft of cover material on the tailings, Option III provides 4 ft of cover, and Option IV provides 13 ft of cover. Costs of the options range from $671,000 to $2,904,000. Reprocessing the tailings for uranium is only marginally feasible and would require a more detailed economic evaluation before any action was taken.

9826 (GJT—6) **Engineering assessment of inactive uranium mill tailings, Durango site, Durango, Colorado. Phase II, Title I.** (Ford, Bacon and Davis Utah, Inc., Salt Lake City (USA)). Nov 1977. Contract EY-76-C-13-1658. 202p. Dep. NTIS, PC A10/MF A01.

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of

radioactive uranium mill tailings at Durango, Colorado. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the 1.555 million tons of tailings at the Durango site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The eight alternative actions presented range from vegetative stabilization (Option I), to contouring and stabilizing in-place with varying depths of cover material (Options II and III), to removal to an isolated long-term disposal site (Options V to VIII). All options include remedial action costs for offsite locations where tailings have been placed. Costs estimated for the eight options range from $4,340,000 to $13,590,000. Reprocessing the tailings for uranium is sufficiently economically attractive to justify reprocessing in conjunction with each of the options.

9827 (GJT—6S) **Engineering assessment of inactive uranium mill tailings, Durango site, Durango, Colorado. A summary of the Phase II, Title I.** (Ford, Bacon and Davis Utah, Inc., Salt Lake City (USA)). Nov 1977. Contract EY-76-C-13-1658. 56p. Dep. NTIS, PC A04/MF A01.

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Durango, Colorado. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the 1.555 million tons of tailings at the Durango site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The eight alternative actions presented range from vegetative stabilization (Option I), to contouring and stabilizing in-place with varying depths of cover material (Options II and III), to removal to an isolated long-term disposal site (Options V to VIII). All options include remedial action costs for offsite locations where tailings have been placed. Costs estimated for the eight options range from $4,340,000 to $13,590,000. Reprocessing the tailings for uranium is sufficiently economically attractive to justify reprocessing in conjunction with each of the options.

9828 (GJT—7) **Engineering assessment of inactive uranium mill tailings, Slick Rock sites, Slick Rock, Colorado. Phase II, Title I.** (Ford, Bacon and Davis Utah, Inc., Salt Lake City (USA)). Oct 1977. Contract EY-76-C-13-1658. 196p. Dep. NTIS, PC A09/MF A01.

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at the two millsites in Slick Rock, Colorado. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals residing nearby, the investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions. The Union Carbide site has 350,000 tons of tailings and the North Continent site now owned by Union Carbide has 37,000 tons of tailings. Both tailings piles have been stabilized in accordance with regulations of the State of Colorado. Radon gas release from the tailings on the sites constitute the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The sparse population and relatively low radiation levels yield minimal immediate environmental impact. Hence the three alternative actions presented are directed towards restricting access to the sites (Option I), and returning the windblown tailings to the piles and stabilizing the piles with cover material (Option II), and consolidating the two piles on the UC site and stabilizing with 2 ft of cover (Option III). Fencing around the tailings piles is included in all options. Options II and III provide 2 ft of cover material on the tailings. Costs of the options range from $370,000 to $1,100,000. Reprocessing the tailings for uranium is not economically feasible.

9829 (GJT—7S) **Engineering assessment of inactive uranium mill tailings, Slick Rock sites, Slick Rock, Colorado. A summary of the Phase II, Title I.** (Ford, Bacon and Davis Utah, Inc., Salt Lake City (USA)). Oct 1977. Contract EY-76-C-13-1658. 58p. Dep. NTIS, PC A04/MF A01.

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at the two millsites in Slick Rock, Colorado. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and other radium-contaminated materials, the evaluation of resulting radiation exposures of individuals residing nearby, the investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions. The Union Carbide site has 350,000 tons of tailings and the North Continent site now owned by Union Carbide has 37,000 tons of tailings. Both tailings piles have been stabilized in accordance with regulations of the State of Colorado. Radon gas release from the tailings on the sites constitute the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The sparse population and relatively low radiation levels yield minimal immediate environmental impact. Hence the three alternative actions presented are directed towards restricting access to the sites (Option I), and returning the windblown tailings to the piles and stabilizing the piles with cover material (Option II), and consolidating the two piles on the UC site and stabilizing with 2 ft of cover (Option III). Fencing around the tailings piles is included in all options. Options II and III provide 2 ft of cover material on the tailings. Costs of the options range from $370,000 to $1,100,000. Reprocessing the tailings for uranium is not economically feasible.

9830 (GJT—8) **Engineering assessment of inactive uranium mill tailings, Naturita site, Naturita, Colorado. Phase II, Title I.** (Ford, Bacon and Davis Utah, Inc., Salt Lake City (USA)). Nov 1977. Contract EY-76-C-13-1658. 153p. Dep. NTIS, PC A08/MF A01.

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Naturita, Colorado. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings sufficient to determine areas and volumes of tailings, the performance of radiometric measurements to determine the extent of radium contamination, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology, and the costing of alternative corrective actions. Radon gas release from the 704,000 tons of tailings at the Naturita site constitutes the most significant environmental impact although windblown tailings and external gamma radiation are also factors. Ranchers Exploration and Development Company has been licensed by the State of Colorado to reprocess the tailings at a location 3 mi from the present site where they will be stabilized for long-term storage. The remedial action options include remedial action for structures in Naturita and Nucla (Option I) at an estimated cost of $270,000 and remedial action for structures and open land adjacent to the tailings site (Option II) at an estimated cost of $950,000.

9831 (GJT—8S) **Engineering assessment of inactive uranium mill tailings, Naturita site, Naturita, Colorado. A summary of the Phase II, Title I.** (Ford, Bacon and Davis Utah, Inc., Salt Lake City (USA)). Nov 1977. Contract EY-76-C-13-1658. 51p. Dep. NTIS, PC A04/MF A01.

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Naturita, Colorado. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings sufficient to determine areas and volumes of tailings, the performance of radiometric measurements to determine the extent of radium contamination, the evaluation of resulting radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology, and the costing of alternative corrective actions. Radon gas release from the 704,000 tons of tailings at the Naturita site constitutes the most significant environmental impact although windblown tailings and external gamma radiation are also factors. Ranchers Exploration and Development Company has been licensed by the State of Colorado to reprocess the tailings at a location 3 mi from the present site where they will be stabilized for long-term storage. The remedial action options include remedial action for structures in Naturita and Nucla (Option I) at an estimated cost of $270,000 and remedial action for structures and open land adjacent to the tailings site (Option II) at an estimated cost of $950,000.

9832 (GJT—9) **Engineering assessment of inactive uranium mill tailings, Grand Junction site, Grand Junction, Colorado. Phase II, Title I.** (Ford, Bacon and Davis Utah, Inc., Salt Lake City (USA)). Oct 1977. Contract EY-76-C-13-1658. 196p. Dep. NTIS, PC A09/MF A01.

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Grand Junction, Colorado. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology and the evaluation and costing of alternative corrective actions. Radon gas release from the 1.9 million tons of tailings at the Grand Junction site constitutes the most significant environmental impact, although windblown tailings

and external gamma radiation are also factors. The eight alternative actions presented range from millsite decontamination (Option I), to adding various depths of stabilization cover material (Options II and III), to removal of the tailings to long-term storage sites and decontamination of the present site (Options IV through VIII). Cost estimates for the eight options range from $470,000 to $18,130,000. Reprocessing the tailings for uranium recovery does not appear to be economically attractive at present.

9833 (GJT—9S) **Engineering assessment of inactive uranium mill tailings, Grand Junction site, Grand Junction, Colorado. A summary of the Phase II, Title I.** (Ford, Bacon and Davis Utah, Inc., Salt Lake City (USA)). Oct 1977. Contract EY-76-C-13-1658. 57p. Dep. NTIS, PC A04/MF A01.

Ford, Bacon and Davis Utah Inc. has performed an engineering assessment of the problems resulting from the existence of radioactive uranium mill tailings at Grand Junction, Colorado. The Phase II, Title I services include the preparation of topographic maps, the performance of core drillings and radiometric measurements sufficient to determine areas and volumes of tailings and radiation exposures of individuals and nearby populations, the investigation of site hydrology and meteorology, and the evaluation and costing of alternative corrective actions. Radon gas release from the 1.9 million tons of tailings at the Grand Junction site constitutes the most significant environmental impact, although windblown tailings and external gamma radiation are also factors. The eight alternative actions presented range from millsite decontamination (Option I), to adding various depths of stabilization cover material (Options II and III), to removal of the tailings to long-term storage sites and decontamination of the present site (Options IV through VIII). Cost estimates for the eight options range from $470,000 to $18,130,000. Reprocessing the tailings for uranium recovery does not appear to be economically attractive at present.

9834 (SAND—77-1021) **Environmental monitoring at the WIPP site CY 1976.** Brewer, L.W.; Metcalf, J.H. (Sandia Labs., Albuquerque, N.Mex. (USA)). Aug 1977. Contract EY-76-C-04-0789. 95p. Dep. NTIS, PC A05/MF A01.

Measurements made in the WIPP study area indicate background exposure levels of 8-9 μR/hr. These measured data are in good agreement with calculated exposure rates (7.5-9.6 μrad/hr). Airborne gross beta concentrations, which were low (0.02 pCi/m^3), confirmed the presence of global fallout from the Chinese nuclear tests conducted in the atmosphere during the fall. The air-quality measurements, except for a few unexplained excursions, were less than State and/or Federal air-quality standards.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 9775, 9779

9835 **Modification in fuel processing of Mitsubishi Nuclear Fuel's Tokai Works.** *Genshiryoku Iinkai Geppo;* **21**: No. 7, 13-15(Oct 1976). (In Japanese).

Results of the study by the Committee for Examination of Fuel Safety, reported to the AEC of Japan, are presented, concerning safety of the modifications of Tokai Works, Mitsubishi Nuclear Fuel Co., Ltd. Safety has been confirmed thereof. The modifications covered are the following: increase in storage facility for nuclear fuel, transfer of the analytical facility, additional fuel assemblage equipment, installation of an incineration facility for combustible solid wastes, installation of an experimental facility for uranium recovery, and installation warehouse.

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 10579

9836 (MLM—2474(OP)) **Nuclear power: new technique for safeguarding special nuclear material.** Woltermann, H.A.; Seabaugh, R.W.; Rogers, D.R.; Fushimi, F.C.; Ciramella, A.F. (Mound Lab., Miamisburg, Ohio (USA)). [nd]. Contract EY-76-C-04-0053. 9p. (CONF-771125—1). Dep. NTIS, PC A02/MF A01.

From 3. international conference of environmental problems of the extractive industries-materials, energy and environment; Dayton, Ohio, USA (29 Nov 1977).

An evaluation was made of the controllable unit approach (CUA) as an alternative to MUF/LEMUF to meet performance oriented regulations. The criterion is detection of material loss of 2 kg of SNM with 97.5 percent confidence. CUF is a material control and accountability methodology that takes into account the system logic and statistical characteristics of a plant process through the formulation of closure equations. The CUA methodlolgy is illustrated through flow diagrams, and its application and performance to a mixed-oxide fuel fabrication plant are compared to those of MUF/LEMUF. (DLC)

9837 (P—5876) **Potential for nuclear terrorism.** Jenkins, B.M. (Rand Corp., Santa Monica, Calif. (USA)). May 1977. 12p. Corp., Santa Monica, CA.

The question of whether or not terrorists will "go nuclear" is discussed. It is possible, although there is no historical evidence that any criminal or terrorist group ever made any attempt to acquire nuclear material for use in an explosive or dispersal device. In terms of intentions, psychotics are potential nuclear terrorists, but in terms of capabilities, they are the farthest away from being able to acquire a nuclear weapon. The history of nuclear incidents in the U.S. and abroad is reviewed. As the nuclear industry expands, the number of low-level incidents (bomb threats, pilferage, etc.) will increase also, but not necessarily escalate to more serious incidents. Terrorists may "go nuclear" solely for the publicity value; nuclear hoaxes may be attenpted. Nuclear terrorism seems more attractive as a threat than as an action. But the nature of the threat may change in the future, and the danger of imitation of a successful nuclear terrorist act is pointed out. (DLC)

9838 (SAND—77-1084C) **Monte-Carlo approach to the generation of adversary paths.** (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 5p. (CONF-771109—30). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

This paper considers the definition of a threat as the sequence of events that might lead to adversary success. A nuclear facility is characterized as a weighted, labeled, directed graph, with critical adversary paths. A discrete-event, Monte-Carlo simulation model is used to estimate the probability of the critical paths. The model was tested for hypothetical facilities, with promising results. (DLC)

9839 (TID—22793/1) **Diversion path analysis handbook. Volume I. Methodology.** Maltese, M.D.K.; Goodwin, K.E.; Schleter, J.C. (National Bureau of Standards, Washington, D.C. (USA). Center for Radiation Research). Oct 1976. 136p. Dep. NTIS, PC A07/MF A01.

Diversion Path Analysis (DPA) is a procedure for analyzing internal controls of a facility in order to identify vulnerabilities to successful diversion of material by an adversary. The internal covert threat is addressed but the results are also applicable to the external overt threat. The diversion paths are identified. Complexity parameters include records alteration or falsification, multiple removals of sub-threshold quantities, collusion, and access authorization of the individual. Indicators, or data elements and information of significance to detection of unprevented theft, are identified by means of DPA. Indicator sensitivity is developed in terms of the threshold quantity, the elapsed time between removal and indication and the degree of localization of facility area and personnel given by the indicator. Evaluation of facility internal controls in light of these sensitivities defines the capability of interrupting identified adversary action sequences related to acquisition of material at fixed sites associated with the identified potential vulnerabilities. Corrective measures can, in many cases, also be prescribed for management consideration and action. DPA theory and concepts have been developing over the last several years, and initial field testing proved both the feasibility and practicality of the procedure. Follow-on implementation testing verified the ability of facility personnel to perform DPA. (DLC)

9840 (TID—22793/2) **Diversion path analysis handbook. Volume II. Example.** Goodwin, K.E.; Maltese, M.D.K.; Schleter, J.C. (National Bureau of Standards, Washington, D.C. (USA). Center for Radiation Research). Oct 1976. 224p. Dep. NTIS, PC A10/MF A01.

An artificial process was developed in order to illustrate the methodology used in the Diversion Path Analysis (DPA). The process might be typical of the end of a fabricating process line where Pu metal bars are recast for storage. The example is presented in the format that is suggested for use when documenting a DPA. This volume is divided into two parts, the workpaper documentation and the summary report. (DLC)

9841 **Isotopic correlation for accounting and control of nuclear materials in a fuel cycle.** Gupta, D. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). *Proc. Jpn. Conf. Radioisot.;* No. 12, 247-292(Jun 1976).

From 12. Japan conference on radioisotopes; Tokyo, Japan (26 Nov 1975).

Review is made to trace the development path of the isotopic correlation technique and indicate the possible areas of its application in the accounting and control of nuclear materials, i.e. in uranium enrichment, reactors, and fuel reprocessing. Large-scale activities both international and national are required to bring the ICT to the level at which nuclear facility operators and safeguard

organizations may use it as a reliable means routinely. Then, the ICT will be used for whole nuclear fuel cycle, not fragmentariiy in individual facilities.

9842 Capable application of RI technology for nuclear material management and control over nuclear fuel cycle. Hirata, Mitsuho (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Proc. Jpn. Conf. Radioisot.;* No. 12, 307-310(Jun 1976).

From 12. Japan conference on radioisotopes; Tokyo, Japan (26 Nov 1975).

The nature of the safeguards for nuclear fuel is first explained concerning the fuel reprocessing in nuclear fuel cycle. In this picture, the heavy element isotope correlation is very effective for the management and control of nuclear materials. The Pu/U values are verified by the isotope correlation. On the other hand, the isotope technology is supported by the relevant data accumulated. Exposure/enrichment averaging effects are explained. The isotopic correlations once established could provide the independent check of the fuel to be reprocessed.

ADMINISTRATIVE AND REGULATORY

REFER ALSO TO CITATION(S) 10579

9843 (SAND—77-1083C) **Considerations in the evaluation of the human element of a safeguards system.** Adams, K.G.; Trujillo, A.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 3p. (CONF-771109—34). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, California, USA (27 Nov 1977).

By understanding the human system and its function, then a structure for evaluating the human system can be developed. This understanding must be available at the research and development levels, and must occur at the working level so that individuals who impact the system will have a common goal in mind. Then by appropriate coordination and review, a system can be developed which will function as designed with a high degree of assurance.

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

PHYSICAL ISOTOPE SEPARATION

9844 Method for enrichment by dual temperature exchange. Spevack, J.S. (to Deuterium Corp.). US Patent 4,047,905. 13 Sep 1977. Filed date 5 Jan 1976. 10p.

In dual temperature systems utilizing different fluid materials in liquid and gas phases separable from each other (for example H_2O and H_2S), the phases are contacted with each other at a relatively hot temperature. Herein combinations of method and means are provided by which the gas is conditioned by raising its temperature and humidity principally by heat derived from the cooling and dehumidification of said gas. Special provisions are made in the combinations for transferring said heat and for the conditioning of the gas with high efficiency; and for economically controlling the temperature of the condensate resulting from the dehumidification of the gas to adapt it for particular uses in the system. Method and means are provided for such liquid gas contacting systems for efficiently stripping or separating dissolved gas from the effluent liquid and returning one of the so separated materials to the system.

9845 Separation of chemical species. Rentzepis, P.M. (to Bell Telephone Labs., Inc.). US Patent 4,044,252. 23 Aug 1977. Filed date 2 Jan 1975. 6p.

Isotopic separation is accomplished by (1) a second photon irradiation step for selective ionization of a first isotopic species and (2) selective precipitation of a generally immiscible liquid from the saturating vapor phase on the ionized species. The first photon corresponds with a sharply defined spectral portion of the irradiation which exclusively excites the first species to a vibrational level. The second photon further excites this species to its ionization level. Selective precipitation is by coulombic attraction between the ionized species and the vapor. The procedure is applicable to any vapor phase ionizable material.

9846 Isotope separation by photodissociation of Van der Wall's molecules. Lee, Y.T. (to Energy Research and Development Administration). US Patent 4,032,306. 28 Jun 1977. Filed date 8 Mar 1976. 8p.

PAT-APPL-664,858.

A method of separating isotopes based on the dissociation of a Van der Waal's complex is described. A beam of molecules of a Van der Waal's complex containing, as one partner of the complex, a molecular species in which an element is present in a plurality of isotopes is subjected to radiation from a source tuned to a frequency which will selectively excite vibrational motion by a vibrational transition or through electronic transition of those complexed molecules of the molecular species which contain a desired isotope. Since the Van der Waal's binding energy is much smaller than the excitational energy of vibrational motion, the thus excited Van der Waal's complex dissociate into molecular components enriched in the desired isotope. The recoil velocity associated with vibrational to translational and rotational relaxation will send the separated molecules away from the beam whereupon the product enriched in the desired isotope can be separated from the constituents of the beam.

9847 Ion laser isotope enrichment by photo-predissociation of formaldehyde. Marling, J.B. (to Energy Research and Development Administration). US Patent 4,029,559. 14 Jun 1977. Filed date 17 Jun 1976. 6p.

PAT-APPL-697,000.

Enrichment of carbon, hydrogen and/or oxygen isotopes by means of isotopically selective photo-predissociation of formaldehyde is achieved by irradiation with a fixed frequency ion laser, specifically, a neon, cadmium, or xenon ion laser.

9848 Isotope enrichment by frequency-tripled temperature tuned neodymium laser photolysis of formaldehyde. Marling, J.B. (to Energy Research and Development Administration). US Patent 4,029,558. 14 Jun 1977. Filed date 22 Oct 1976. 6p.

PAT-APPL-734,840.

Enrichment of carbon, hydrogen and/or oxygen isotopes by means of isotopically selective photo-predissociation of formaldehyde is achieved by irradiation provided by a frequency-tripled, temperature tuned neodymium laser.

HEAVY WATER PRODUCTION

9849 Deuterium separation by infrared-induced addition reaction. Marling, J.B. (to Energy Research and Development Administration). US Patent 4,025,408. 24 May 1977. Filed date 28 May 1976. 8p.

PAT-APPL-691,258.

A method is described for deuterium enrichment by the infrared-induced addition reaction of a deuterium halide with an unsaturated aliphatic compound. A gaseous mixture of a hydrogen halide feedstock and an unsaturated aliphatic compound, particularly an olefin, is irradiated to selectively vibrationally excite the deuterium halide. The excited deuterium halide preferentially reacts with the unsaturated aliphatic compound to produce a deuterated addition product which is removed from the reaction mixture. 15 claims, 1 figure.

RADIATION SOURCES

9850 Gamma-irradiation treatment apparatus. Sieber, A. (to Sulzer Brothers Ltd.). US Patent 4,048,509. 13 Sep 1977. Priority date 21 Aug 1974, Switzerland. 4p.

The radiation source mounting frame is raised and lowered by means of an elevator comprised of a block and tackle and a servomotor having an output connected to a movable pulley block of the block and tackle. The elevator allows the mounting frame to be lowered at a rapid rate when necessary. The supply line for the pressure medium is also disposed near the end of the piston stroke so that the line can be throttled before the piston reaches the end of its stroke. This allows the final descent of the mounting frame to be retarded.

DESIGN AND FABRICATION

9851 X-ray source safety shutter. Robinet, M. (to Energy Research and Development Administration). US Patent 4,027,156. 31 May 1977. Filed date 25 May 1976. 6p.

PAT-APPL-689,890.

An apparatus is provided for controlling the activation of a high energy radiation source having a shutter. The apparatus includes magnets and magnetically responsive switches appropriately placed and interconnected so that only with the shutter and other parts of the source in proper position can safe emission of radiation out an open shutter occur.

ISOTOPIC POWER SUPPLIES

REFER ALSO TO CITATION(S) 10942, 10947

9852 (LA—6886-MS) **Statistical analysis and planning of multi-hundred-watt impact tests.** Martz, H.F. Jr.; Waterman, M.S. (Los

Alamos Scientific Lab., N.Mex. (USA)). Oct 1977. Contract W-7405-ENG-36. 16p. Dep. NTIS, PC A02/MF A01.

Modular multihundred-watt (MHW) radioisotope thermoelectric generators (RTG's) are used as a power source for spacecraft. Due to possible environmental contamination by radioactive materials, numerous tests are required to determine and verify the safety of the RTG. There are results available from 27 fueled MHW impact tests regarding hoop failure, fingerprint failure, and fuel failure. Data from the 27 tests are statistically analyzed for relationships that exist between the test design variables and the failure types. Next, these relationships are used to develop a statistical procedure for planning and conducting either future MHW impact tests or similar tests on other RTG fuel sources. Finally, some conclusions are given.

DESIGN AND FABRICATION

9853 (LA—7003-PR) **General-Purpose Heat Source Project, space nuclear safety program, and radioisotopic terrestrial safety program. Progress report, September 1977.** Baker, R.D. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1977. Contract W-7405-ENG-36. 55p. Dep. NTIS, PC A04/MF A01.

The formal monthly report covers the studies related to the use of $^{238}PuO_2$ in radioisotopic power systems carried out for the Division of Nuclear and Applications by the Los Alamos Scientific Laboratory. The three programs involved are: general-purpose heat source development; space nuclear safety; and radioisotopic terrestrial safety.

HYDROGEN

REFER ALSO TO CITATION(S) 10603

PRODUCTION

REFER ALSO TO CITATION(S) 9625, 10285, 11293

ELECTROLYSIS

REFER ALSO TO CITATION(S) 9934, 10287

THERMOCHEMICAL PROCESSES

9854 (UCRL—80282) **Revised flowsheet and process design for the ZnSe thermochemical cycle.** Krikorian, O.H.; Otsuki, H.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 Oct 1977. Contract W-7405-ENG-48. 11p. (CONF-771131—1). Dep. NTIS, PC A02/MF A01.

From DOE annual chemical energy storage and hydrogen energy system contracts review; Baltimore, Maryland, USA (16 Nov 1977).

We have completed a preliminary process design, flowsheet, and an economic analysis of an improved version of the ZnSe cycle for hydrogen production. The amount of $ZnSO_4$ that needs to be decomposed at high temperatures has been reduced by a factor of 2 in this revised cycle, thereby both lowering overall heat requirements and spreading out the prime heat required over a broader temperature range than before. Corresponding inprovements have been achieved in both cycle efficiency and equipment costs. Assuming a VHTR nuclear reactor heat source and incorporating special equipment designs for critical steps in the cycle, we now obtain an overall cycle efficiency of about 40 percent and a hydrogen production cost of about $13/GJ. We believe that this cost is conservative at this point of cycle development because the input data on reaction rates and equipment lifetimes have been conservative, and the analysis has not been optimized.

COAL GASIFICATION

REFER ALSO TO CITATION(S) 10289

STORAGE

CHEMISORPTION

REFER ALSO TO CITATION(S) 10677

9855 **Hydrogen absorption and desorption properties of AB_2 Laves-phase pseudobinary compounds.** Shaltiel, D.; Jacob, I.; Davidov, D. (Hebrew Univ., Jerusalem (Israel). Racah Inst. of Physics). *J. Less-Common Met.;* **53**: No. 1, 117-131(May 1977).

The formation and properties of the hydrides of the pseudobinary intermetallic compounds $Zr(Cosub(x)Msub(1-x))_2$ and $Zr(Fesub(x)Msub(1-x))_2$ (M = V, Cr, Mn; $0<x<1$) have been studied at various temperatures and in the pressure range up to 70 atm. It is demonstrated that many of the pseudobinary compounds exhibit excellent sorption properties, i.e. they absorb approximately three hydrogen atoms per molecule and exhibit a plateau dissociation pressure around 1 atm at room temperature. The hydrogen capacity Nsub(H) decreases with increase of the 3d occupation number across the 3d series. The results are discussed in terms of the 'rule of reversed stability' of Van-Mal and the theory of Miedema. There is qualitative agreement between experiment and theory. A list of new hydrides based on AB_2 Laves-phase compounds which contain large quantities of hydrogen is given in the Appendix. In view of the work on the pseudobinary compounds of Zr, a general method of increasing the plateau pressure of intermetallic compounds is suggested.

INDUSTRIAL AND COMMERCIAL USE

REFER ALSO TO CITATION(S) 10668, 10671, 10677

OTHER SYNTHETIC AND NATURAL FUELS

REFER ALSO TO CITATION(S) 9930

9856 (CONF-7605160—, pp 79-121) **Status of synfuel utilization emission and residuals management.** Lukens, L.A.; Wallace, B.L. (Navy Energy Research and Development Office, Annapolis, MD). 1976.

From 1. symposium on management of residuals from synthetic fuels production; Denver, Colorado, USA (25 May 1976).

In Proceedings of the first symposium on management of residuals from synthetic fuels production.

It is shown why the Navy and the Dept. of Defense are interested in synthetic fuels. The properties of oil shale crude produced by Parabo are mentioned. A series of component hardware and engine tests on boilers, diesels, gas turbines (both marine and aircraft types), and spark ignition engines were conducted to determine the performance and emission characteristics of the shale-derived fuels in comparison with petroleum-based fuels. Full-scale operational tests were also conducted using an ore carrier and aircraft. The Navy's toxicology program is next considered, and the steps taken to qualify a synthetic fuel for use are shown. A shipboard atmosphere characterization program has been initiated and is described. The DoD program on synthetic fuels is now aiming at the 100,000-barrel level. (DLC)

HYDROCARBON FUELS

REFER ALSO TO CITATION(S) 10047, 10670

PROPERTIES

9857 (COO/4272—1) **Fundamental and semi-global kinetic mechanisms of hydrocarbon combustion. Progress report, March 1—September 30, 1977.** Glassman, I.; Dryer, F.L. (Princeton Univ., N.J. (USA). Dept. of Aerospace and Mechanical Sciences). Sep 1977. Contract EC-77-S-02-4272. 40p. Dep. NTIS, PC A03/MF A01.

Major emphasis in combustion research is being given to the study of oxidation of hydrocarbon fuels to lend insight into the modelling of combustion processes. The introduction of combustion chemistry into the already complex turbulent flow situations which exist in practical devices make modelling exceptionally difficult. Semi-global reaction mechanisms offer the potential of reducing the overall chemical kinetic complexity, thus substantially reducing the computational barriers to appropriate modelling of combustion processes. Reported here are the results of efforts presently underway at Princeton under ERDA support, to provide a general understanding of hydrocarbon oxidation. Specifically the results of studies of the lean oxidation of ethane along with the developed semi-global rates are reported. Initial results for the lean oxidation of propane are discussed and the present status of studies on methanol oxidation is also reported.

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 9558, 9601

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 9864, 9931, 9932, 10720

ALCOHOL FUELS

REFER ALSO TO CITATION(S) 10665, 10672, 10674

PROPERTIES

REFER ALSO TO CITATION(S) 9857

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 9928

SOLID WASTE FUELS

REFER ALSO TO CITATION(S) 10571, 10857

SOLAR ENERGY

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 9866, 9868, 10574

9856 (ERDA/NASA—1022/76/10, pp 1-15) **Monitoring solar radiaton: the ERDA program.** Koomanoff, F.A.; Riches, M.R. (Energy Research and Development Administration, Washington, DC). 1977.

From Terrestrial PV measurements workshop; Baton Rouge, Louisiana, USA (10 Nov 1976).

In Terrestrial photovoltaic measurements. II.

An overview of the Energy Research and Development Administration planned insolation data network is described. The design of this network is predicated on an analysis and definition of user requirements. Research and analysis projects covering data collection, forecasting and extrapolation are presented.

9859 (ERDA/NASA—1022/76/10, pp 17-58) **Solar spectrum at typical clear weather days.** Boeer, K.W. (Univ. of Delaware, Newark). 1977.

From Terrestrial PV measurements workshop; Baton Rouge, Louisiana, USA (10 Nov 1976).

In Terrestrial photovoltaic measurements. II.

The solar spectrum in the range of 300 less than lambda less than 1500 nm is given for five typical clear weather days. These days are selected to represent typical seasonal conditions in respect to airmass water vapor, ozone, and turbidity. Present data are reviewed, and specific conditions are selected. The spectral distribution of the irradiance is given for the direct component, the scattered skylight, the total flux on a horizontal surface, and the flux on an inclined surface normal to the direct beam. 28 references.

9860 (ERDA/NASA—1022/76/10, pp 59-66) **Insolation measurements with a portable Cu_2S—CdS radiometer.** Windawi, H.M. (Univ. of Delaware, Newark). 1977.

From Terrestrial PV measurements workshop; Baton Rouge, Louisiana, USA (10 Nov 1976).

In Terrestrial photovoltaic measurements. II.

Solar radiation measurements were carried out with a portable Cu_2S-CdS radiometer. The measurements were found to be accurate to better than 5 percent (better than 3 percent when sophisticated metering is employed). Calibration to an Eppley Precision Pyranometer is discussed.

9861 (ERDA/NASA—1022/76/10, pp 183-202) **New rapid method of solar simulator calibration.** Ross, B. 1977.

From Terrestrial PV measurements workshop; Baton Rouge, Louisiana, USA (10 Nov 1976).

In Terrestrial photovoltaic measurements. II.

A quick method for checking solar simulator spectral content is presented. The method is based upon a solar cell of extended spectral sensitivity and known absolute response, and a dichroic mirror with the reflection-transmission transition close to the peak wavelength of the Thekaekara AMO distribution. Measurements were conducted at eleven major facilities across the country and a total of eighteen simulators was measured including five pulsed units. Measurements consisted of exposing the violet solar cell to the simulator light by transmission through the dichroic mirror and reflection from its front surface. A backup measurement was done using five bandpass filters furnished by NASA-Goddard Space Flight Center. The filters and mirror were made available at no cost to the Air Force and the several firms and organizations generously provided their time, facilities and cooperation in these measurements. Data are presented from the results of the measurements, and compared with the expected values from calculations. The degree of agreement is discussed and problem areas identified. Extension of the method to AM2 simulation is simple and requires but one further calculation.

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 10611

9862 (JPL—5040-13, pp 24-31) **FEA plans for federal incentives and market evaluation.** Lutkefeder, N. 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The Federal laws covering solar energy are listed. The role of the Federal Energy Administration, its commercialization effort, its program areas, and the projects currently being addressed are outlined. The solar energy bills proposed in 1975 are listed according to introduction in the House or the Senate. (MHR)

SOLAR ENERGY CONVERSION

PHOTOVOLTAIC CONVERSION

9863 (ALO/3727—77/1) **Thin polycrystalline films of indium phosphide on low-cost substrates. Quarterly report No. 1, September 30, 1976—January 1, 1977 .** Ruth, R.P.; Dapkus, P.D.; Manasevit, H.M.; Hess, K.L.; Johnson, R.E.; Moudy, L.A. (Rockwell International Corp., Anaheim, Calif. (USA). Electronics Research Div.). Sep 1977. Contract EY-76-C-04-3727. 63p. Dep. NTIS, PC A04/MF A01.

Plans for the six main technical tasks of this 12-month program are discussed and the activities of the first three months are summarized. A new reactor system for growing thin films of InP by the metallorganic-hydride chemical vapor deposition (MO-CVD) process has been completed. Experiments using triethylindium (TEI) and phosphine (PH_3) reactants in a H_2 carrier gas have shown that InP films can be successfully grown over a range of deposition temperatures. Epitaxial growth of single-crystal films has been obtained on at least two different crystallographic orientations of single-crystal GaAs at temperatures as low as approximately 525°C, and there is evidence that the process can be utilized at even lower temperatures—perhaps below approximately 475°C. Films not intentionally doped are n type, with measured carrier concentrations in the 10^{16} cm^{-3} range and electron mobilities up to approximately 2000 cm^2/V-sec (room temperature). Initial investigations involve single-crystal substrates (GaAs, sapphire, InP) but various low-cost materials—glasses, alumina ceramics, metals, and certain composites of these—are being selected and evaluated for subsequent use in the program. Specific candidate materials are discussed. The program also involves the formation and evaluation of heterojunction photovoltaic device structures using the InP layers formed by MO-CVD and deposited films of CdS, ZnCdS, and similar II-VI compounds and alloys; this work is done at Stanford University. During the first quarter, two techniques for producing ohmic contacts of Au/Zn/Au on p-type InP were successfully developed, with low contact resistances being achieved following annealing in H_2 at temperatures up to 475°C. Planned work for the next quarter is outlined.

9864 (COO—2991-17) **Fuel gas production from animal waste. Phase I. Annual summary report, May 17, 1976—May 17, 1977.** Ashare, E.; Wentworth, R.L.; Wise, D.L.; Augenstein, D.C. (Dynatech R/D Co., Cambridge, Mass. (USA)). 31 May 1977. Contract EY-76-C-02-2991. 30p. Dep. NTIS, PC A03/MF A01.

Quarterly coordination and review meetings were held with contractors in the area of fuel gas from animal residue via anaerobic digestion. Site visits to individual contractors were made to discuss progress of work. An engineering and economic analysis was performed for an anaerobic digestion process for the production of fuel gas from animal wastes. A comprehensive engineering report was prepared describing this study. A study of processes for the removal of acid gases from digester gas has been initiated. This study is directed at reviewing the technology and assessing the technical and economic feasibility of gas scrubbing technology for removal of CO_2 from digester gas. Proposals submitted to ERDA in the field of fuel gas from biomass were reviewed and evaluated.

9865 (ERDA/JPL/954605—77/2) **Development of low-cost, high energy-per-unit-area solar cell modules. Quarterly report No. 2.** Jones, G.T.; Chitre, S. (Sensor Technology, Inc., Chatsworth, Calif. (USA)). Jun 1977. Contract NAS-7-100-954605. 58p. Dep. NTIS, PC A04/MF A01.

Hexagonal solar cell and module efficiencies, module packing ratio, and solar cell design calculations were made. The cell grid structure and interconnection pattern was designed. The module substrate which includes the aluminum pan, aluminum plate, and mounting brackets were designed and fabricated for the three modules to be used in Phase I of this contract program. It was demonstrated that a laserscribe can clearly cut through the p-n junction of the solar cell without causing excessive current leakage across the junction. Full hexagons and half hexagons can be cut by laser without causing excessive loss in photovoltaic energy conversion efficiency. The solar cell surface macrostructure study and diffusion study continued. It was demonstrated that surface macrostructures significantly improve solar cell power output and photovoltaic energy conversion efficiency. Silicon wafer surface preparation and etching time, temperature and concentration was optimized relative to surface macrostructures that trap light efficiently. The spectral response of these cells showed superior light absorption over our commercial solar cell. A diffusion furnace temperature profile study indicates that with only a few modifications to our equipment, 400 silicon wafers per hour can be diffused. A study to determine the optimum silicon ingot diameter to be utilized for modified hexagonal solar cells as a function of the relative silicon material costs, solar cell packaging costs, and solar cell module system costs was completed. A method is presented for determining the optimum low-cost, high energy-per-unit-area solar cell module system.

9866 (ERDA/NASA—1022/76/10) **Terrestrial photovoltaic measurements. II.** (Energy Research and Development Administration, Washington, D.C. (USA); National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1977. Contract EX-76-A-29-1022. 404p. (CONF-761129—; NASA-CP—2010). Dep. NTIS, PC A18/MF A01.

From Terrestrial PV measurements workshop; Baton Rouge, Louisiana, USA (10 Nov 1976).

Separate abstracts were prepared for 13 of the 24 papers presented. Eleven of the papers were previously abstracted in ERA and can be located in the report number index under the report number CONF-761129. (WHK)

9867 (ERDA/NASA—1022/76/10, pp 109-150) **Solar excitation of CdS/Cu_2S photovoltaic cells.** Boeer, K.W. (Univ. of Delaware, Newark). 1977.

From Terrestrial PV measurements workshop; Baton Rouge, Louisiana, USA (10 Nov 1976).

In Terrestrial photovoltaic measurements. II.

Solar radiation of five typical clear weather days and under a variety of conditions is used to determine the spectral distribution of the photonflux at different planes of a CdS/Cu_2S solar cell. The fractions of reflected and absorbed flux are determined at each of the relevant interfaces and active volume elements of the solar cell. The density of absorbed photons is given in respect to spectral and spatial distribution. The variance of the obtained distribution, with changes in insolation and absorption spectra of the active solar cell layers, is indicated. A catalogue of typical examples is given in the appendix.

9868 (ERDA/NASA—1022/76/10, pp 151-152) **Insolation measurements and associated spectral effects at remote military installations.** Bond, J.W. Jr. (Army Mobility Equipment Research and Development Command, Fort Belvoir, VA). 1977.

From Terrestrial PV measurements workshop; Baton Rouge, Louisiana, USA (10 Nov 1976).

In Terrestrial photovoltaic measurements. II.

The lack of insolation data for making sizing estimates for solar cell battery chargers for remote Department of Defense installations is pointed out. It is recommended that ERDA begin immediately to provide instrumentation at key military installations to obtain the needed solar insolation and spectral data. (WHK)

9869 (ERDA/NASA—1022/76/10, pp 223-231) **Laser based characterization facility for silicon photocell studies.** Geist, J.; Lind, M.A.; Schaefer, A.R.; Zalewski, E.F. (National Bureau of Standards, Washington, DC). 1977.

From Terrestrial PV measurements workshop; Baton Rouge, Louisiana, USA (10 Nov 1976).

In Terrestrial photovoltaic measurements. II.

A computer-controlled, laser-based characterization facility for spectral response measurements on silicon solar cells is described. The facility setup and control systems are described, and various applications of the test facility are discussed. (WHK)

9870 (ERDA/NASA—1022/76/10, pp 301-307) **Cell and module test procedures seen from the manufacturer and the user point of view.** Durand, H. (Laboratoires d'Electronique et de Physique Appliquee, Limeil, France). 1977.

From Terrestrial PV measurements workshop; Baton Rouge, Louisiana, USA (10 Nov 1976).

In Terrestrial photovoltaic measurements. II.

Some of the problems which are usually not taken into account by "conventional" test procedures, but which are of the utmost importance to the manufacturers and users of solar modules, are summarized. Amongst them, a clear definition, and its related measurement, of the "rated" power of a module should be of great help to define the actual performance of a module. A very simple temperature test, acceptable for modules due to their higher thermal capacity, is suggested. Various practical considerations dealing with cell and module technologies lead to the conclusion that reference bare cells are not well suited for module test procedures. Finally, some suggestions are made for environmental module and array tests and for some other practical data to be introduced in the future specifications.

9871 (ERDA/NASA—1022/76/10, pp 323-335) **Recommendations for the performance rating of flat plate terrestrial photovoltaic solar panels.** Treble, F.C. (Royal Aircraft Establishment, Farnborough, Eng.). 1977.

From Terrestrial PV measurements workshop; Baton Rouge, Louisiana, USA (10 Nov 1976).

In Terrestrial photovoltaic measurements. II.

Earlier this year, (1976) the author made recommendations for standardising the performance rating of flat-plate terrestrial solar panels which were subsequently amended at a meeting of the Solar Photovoltaic Working Group of the Commission of the European Communities (CEC). It is proposed to review the amended recommendations and indicate where they differ from the ERDA/NASA Interim Procedures. While the Working Group recommendations cannot yet be assumed to represent an official CEC viewpoint, it is hoped that this discussion will lead the way to an international standard code of practice for performance rating, which will enable all engaged in the research, design, development, marketing and procurement of solar panels to evaluate different designs on a valid and reliable basis.

9872 (ERDA/NASA—1022/76/10, pp 347-353) **Determination of series resistance and diode quality factor.** Anderson, R.L. (Syracuse Univ., NY). 1977.

From Terrestrial PV measurements workshop; Baton Rouge, Louisiana, USA (10 Nov 1976).

In Terrestrial photovoltaic measurements. II.

The series resistance and diode quality factor are important parameters used for evaluation of solar cell performance. These parameters are normally deduced from the terminal I-V characteristics under forward bias. This method produces a smaller series resistance and a larger value for diode quality factor than appropriate for the device when operating as a solar cell. It is suggested that the diode quality factor be determined from measured saturated photocurrent—open circuit voltage characteristics and the series resistance be measured with an r-f bridge or calculated from a measurement of the surface sheet resistance.

9873 (ERDA/NASA—1022/76/10, pp 355-361) **Problems in photoresponse distribution measurement.** Minagawa, S.; Warabisako, T. (Hitachi Ltd., Kokubunji, Japan). 1977.

From Terrestrial PV measurements workshop; Baton Rouge, Louisiana, USA (10 Nov 1976).

In Terrestrial photovoltaic measurements. II.

Photoresponse distribution measurement by scanning a light spot across a surface of a semiconductor device is often used in a variety of sections of device characterization. This technique is very useful for solar cell characterization because the measured quantity is the direct expression of the distribution of the desired performance of the device. Researchers of the thin-film solar cell must be implemented with this kind of apparatus, because the thin-film cell includes many defects, grain boundaries and precipitates in some cases which cause nonuniform and poor performance. Characterization of these defects and techniques for eliminating these maleffects must be explored before the thin-film solar cells can supply low cost electric energy. An apparatus for measuring the photoresponse distribution and use it in the development of polysilicon thin-film solar cells are described.

9874 (ERDA/NASA—1022/76/10, pp 363-383) **Collection efficiency measurements for solar cell research.** Hampton, H.L.; Olsen, L.C. (Joint Center for Graduate Study, Richland, WA). 1977.

From Terrestrial PV measurements workshop; Baton Rouge, Louisiana, USA (10 Nov 1976).

In Terrestrial photovoltaic measurements. II.

A system has been established for measuring absolute, spectral collection efficiency that is well suited to solar cell research and development. In particular, the required equipment is relatively inexpensive, the measurement procedure is straightforward, and the approach allows for the study of high resistance or "leaky" cells. Determination of spectral collection efficiency, Q(lambda), involves measurements of the incident photon intensity, the device reflection

coefficient R(lambda), and the cell short-circuit current I/sub sc/ (lambda). A monochromatic photon flux is obtained with a high intensity Bausch and Lomb monochromator, and an Epply thermopile detector is used to measure incident intensity. Normal incidence reflectivity measurements are achieved with a prism type beam splitter. Reflectivity vs lambda has been measured for evaporated Ag films and agree to within 2 percent of those previously reported by Haas in the visible region. Measurements of Q/sub lambda/ vs lamdba have been made for 2 Ω-cm, silicon solar cells and for Cu_2O devices. The same silicon cells were sent to NASA-Lewis for quantum-yield measurements. Our results agree extremely well with those of NASA-Lewis.

9875 (ERDA/NASA—1022/76/10, pp 385-391) **Spectral response measurements with white light bias.** Devaney, W.; Lorenz, S.; Meakin, J.D. (Univ. of Delaware, Newark). 1977.

From Terrestrial PV measurements workshop; Baton Rouge, Louisiana, USA (10 Nov 1976).

In Terrestrial photovoltaic measurements. II.

The spectral response of certain solar cells such as the CdS/Cu_2S cell is well known to be non-linear with distinct quenching and enhancement bands. One possible technique to produce standardized solar efficiencies is to fold in spectral response with a standard solar spectrum. It is therefore necessary to measure the spectral response of a cell in a way which will match cell behavior under white light illumination. A technique has been developed to measure the response of a cell to low intensity chopped monochromatic light while the cell is also illuminated with a white light bias corresponding to AMI.

9876 (JPL—5040-13) **Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.** (Jet Propulsion Lab., Pasadena, Calif. (USA)). 1975. Contract NAS-7-100. 743p. (CONF-750725—). .

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

Forty-five papers are included. Separate abstracts were prepared for each paper. (MHR)

9877 (JPL—5040-13, pp 32-49) **Mission analysis of photovoltaic solar energy systems.** Leonard, S.L. 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The development of the computer software needed in the methodology for evaluating on-site missions is described. The evaluation methodology was used for analyzing a baseline concept, a residential photovoltaic concept located in Phoenix. Implementing procedures for evaluating central station power plant applications are mentioned. Some data are presented from the Phoenix residential system. (MHR)

9878 (JPL—5040-13, pp 50-53) **Status of the photovoltaic conceptual design and systems analysis RFP.** Magid, L.M. (Energy Research and Development Administration, Washington, DC). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The National Photovoltaic Conversion Program awarded three contracts totaling slightly more than $1.4M for the first Conceptual Design and Systems Analysis studies of solar photovoltaic conversion systems. The systems to be analyzed and the contractors are listed.

9879 (JPL—5040-13, pp 56-61) **Low-cost silicon solar array project.** Goldsmith, J.V. (California Inst. of Tech., Pasadena). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The organization, relative roles of government and industry, 1985 project technical requirements, summary improvement required, and task interactions for the low-cost silicon solar array project are outlined. (MHR)

9880 (JPL—5040-13, pp 62-64) **Photovoltaic conversion of solar energy.** Cleland, J.W.; Westbrook, R.D.; Davis, H.L.; Wood, R.F. (Oak Ridge National Lab., TN). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The objectives and past, present, and future efforts in the photovoltaic conversion work are discussed briefly. Results on the applicability of "nuclear doped" silicon to the silicon solar cell are described. (MHR)

9881 (JPL—5040-13, pp 65-88) **Development of a 20% efficient solar cell.** Lindmayer, J. (SOLAREX Corp., Rockville, MD). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The work has proceeded along the lines which are basic to inexpensive technologies, such as the use of CZ crystals, chemical surface preparation, short junction formation in quantity, back junction formation by simple alloying, no clean room operation, etc. Progress in efficiency was continuous and the 20 percent efficiency was almost reached.

9882 (JPL—5040-13, pp 89-103) **Solar silicon definition grant.** Wakefield, G.F. (Texas Instruments, Inc., Dallas). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

This project is being conducted to define a preliminary chemical purity specification for solar grade silicon. The approach was to prepare crystals from high purity silicon doped to known level with many common impurities. This impure silicon was fabricated into small area diodes and solar cells to evaluate the effect of the impurities on device performance. Measurements were made of the I-V characteristics (with emphasis on the slope of the recombination and injection influenced curves), the photoresponse behavior and lifetime measurement by photoconductive decay technique. Following selection of the maximum levels of impurities tolerable within the performance criteria, samples of impure silicon were fabricated into solar cells by several solar cell manufacturers. The performance of these cells was compared to performance of cells fabricated simultaneously from semiconductor silicon by the same manufacturer to eliminate processing variables. The results of the diode evaluation showed that up to several ppM of most common impurities were tolerable in the raw material silicon used for crystal growth. The impure silicon provided for solar cell manufacturers tests was grown from silicon containing 10 ppM of each of the impurities being studied, for a total impurity level of 120 ppM in the melt. The solar cells made from the impure silicon were consistently lower in performance by .5 to 1 percent absolute from all sources. The V/sub OC/ and I/sub SC/ were reduced .5750 to .565 V and 31 to 20 ma/cm² for 2" diameter cells semiconductor grade silicon and the impure silicon respectively. Cells from the impure silicon thus performed 90 percent as well as cells made from silicon having 10^4 - 10^5 higher purity level. The consistency of data from several sources of fabrication and the normal distribution shape of the yield curve tend to support the validity of the data.

9883 (JPL—5040-13, pp 104-121) **EFG ribbon growth.** Ravi, K.V. (Mobil Tyco Solary Energy Corp., Waltham, MA). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

Effort has been devoted to the examination of the shape of the meniscus at the ribbon edges. It has been determined that the height of the meniscus at the ribbon edges was underestimated in the earlier theory. Present theoretical findings along with analog experiments indicate that the side meniscus lifts the edge meniscus effectively increasing the meniscus height at the edges. This finding has important consequences in the stable growth of high quality ribbons. Other factors considered include the effects of crystal orientation on ribbon shape or morphology. The experimental aspects of growth have dealt with continuous ribbon growth and factors contributing to ribbon quality. Continuous ribbons of up to 80 ft (1 in. wide, 8 to 10 mils thick) in length have been grown. With the use of top or die heaters in resistance heated crystal growth systems, the control of vertical temperature gradients as well as the height of the meniscus above the die is possible. By employing a high meniscus mode of operation of the system a few crystals of very high quality with respect to defect densities (dislocations, twins and SiC particles) have been grown. The crystals also maintain a constant orientation over long lengths. The quality aspects of ribbon crystals have been under continuous investigation with new insights into the characteristics of linear boundaries and SiC particles being developed.

9884 (JPL—5040-13, pp 122-149) **EFG silicon ribbon solar cells.** Ravi, K.V.; Serreze, H.B.; Bates, H.E.; Morrison, A.D.; Jewett, D.N.; Ho, J.C.T. (Mobil Tyco Solary Energy Corp., Waltham, MA). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The growth and characteristics of edge-defined, film-fed grown (EFG) silicon ribbons are discussed. Factors involved in the growth of continuous lengths of 1 in. wide ribbons are examined. The structural and electrical characteristics of the ribbons have been

studied and the results are presented. Solar cells have been fabricated using the ribbon crystals and typical AMO efficiencies of 6 to 10 percent have been realized.

9885 (JPL—5040-13, pp 150-171) **Silicon ribbon growth using a capillary action shaping technique.** Schwuttke, G.H.; Ciszek, T.F.; Kran, A. (International Business Machines Corp., Hopewell Junction, NY). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

A review of work performed is presented, along with an outline of the project concept and work plan. The crystal growth method involves Meniscus shaping at the vertex of a wettable die. As ribbon growth depletes the melt meniscus, capillary action supplies replacement material. Because of the die/melt proximity, a durable, nonreactive die is desirable. A number of materials have been collected for die evaluation and are being machined. Crystal growth to date has been done with graphite and silicon carbide dies. Graphite dies lead to particle inclusions in the ribbon surface. The particles were identified as beta silicon carbide. Silicon carbide particles and carbon cause defect nucleation in otherwise defect-free ribbons. A number of 12 mm wide x 0.5 mm thick x 1 m long ribbons were grown to thoroughly characterize the state-of-the-art multicrystalline ribbons, and are in the process of scale-up to 25 mm widths while studying process changes for improved ribbon structure. An expression for maximum potential ribbon growth rates was derived and the results are shown graphically. Silicon tubes 6 mm in wall thickness, and over 1 m in length were grown by the capillary action shaping technique.

9886 (JPL—5040-13, pp 172-193) **Research and development of low cost processes for integrated solar arrays.** Wolf. M.; Crossman, L. 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The current phase of the project is directed toward the technical and economic feasibility assessment of competing process approaches. The emphasis has continued on the areas of Si reduction and purification and of sheet generation. Previously unexplored Si transport properties of the SiF_2 reaction at atmospheric pressure have been further investigated. It has been firmly established that the SiF_2 gas can be moved without decomposition at constant temperature both above 1000°C and below 100°C, with Si deposition occuring at the intermediate temperatures. Considerable progress was made in the exploration of the high temperature mechanical properties of polycrystalline Si, with the objective of assessing the feasibility of plastic deformation, such as rolling. Deformations by up to 70 percent at strain rates up to 1 percent/s have indicated that plastic deformation of Si may be a suitable forming method. Earlier problems with the anisotropic crystal structures in the "polyrods" resulting from the $SiHCl_3$ purification process have been overcome by raising temperature and strain. Also, crystallization has been observed to take place, including grain growth by an order of magnitude. The float zone recrystallization equipment to be used for the exploration of the conversion of polycrystalline sheet to single crystal sheet by, heating with a planar electron beam is now completed, with experimentation scheduled to begin. In preparation for the ultimate economic analysis of competing processes, a thorough economic evaluation, with evolution forecast of the Czochralski process as a baseline has been carried out.

9887 (JPL—5040-13, pp 194-211) **Low-cost processes for solar-grade silicon.** Hunt, L.P.; Crossman, L.D.; Wolf, M. 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The objective is to determine the best process for the high-volume production of solar-grade silicon (SoG-Si) at less than $10/kg within the ERDA milestone of having a pilot plant available by mid-1980. The overall process screening approach which began with over 200 possible reactions leading to silicon has reduced this number to ten which still fall within the constraints mentioned above. Two of these reactions involve the direct reduction of silica to silicon via aluminum or carbon. Seven other reactions involve the use of various reductants to convert silica to silicon via intermediate silicon monoxide. The tenth reaction uses recyclable SiF_4 to transport in situ produced silicon via intermediate SiF_2. The reactions described above, in addition to processes involving silicates and/or electrolytic techniques, have been divided into two broad categories: (1) metallurgical grade silicon (MG-Si) process upgrading, and (2) other processes. This was done since the commercial process for producing MG-Si already meets the high-volume, low-cost guidelines for SoG-Si and, therefore, has a good probability of meeting the mid-1980 pilot plant milestone. The other processes are still in the conceptualization or research stage. Key results are summarized.

9888 (JPL—5040-13, pp 214-231) **Photovoltaic test and demonstration project for the national photovoltaic conversion program.** Deyo, J.N. (National Aeronautics and Space Administration, Cleveland). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The organizational structure of the program is sketched. The activities, objectives, technical approach and possible applications are outlined for each of the three parts of the program: tests and model system demonstrations, device performance and diagnostics, and endurance testing. (MHR)

9889 (JPL—5040-13, pp 251-259) **Review of terrestrial photovoltaic measurements workshop.** Brandhorst, H.W. Jr. (National Aeronautics and Space Administration, Cleveland). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

A Terrestrial Photovoltaic Measurements Workshop was held at the NASA-Lewis Research Center, March 19-21, 1975. The purpose of this meeting was to make recommendations on measurement methods and the terrestrial solar intensity and spectrum to be used by investigators in the Solar Photovoltaic Energy Conversion Program. The workshop was divided into three major areas. About 25 papers covering these three areas were presented. Broad agreement was obtained on an interim method for making terrestrial solar cell measurements. The major recommendations of the workshop are shown. These recommendations have been translated into an interim test procedure to be used by all photovoltaic investigators. The key aspects of this procedure are summarized.

9890 (JPL—5040-13, pp 262-278) **Investigation of terrestrial photovoltaic power systems with sunlight concentration.** Backus, C.E. (Arizona State Univ., Tempe). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The analytical model of the silicon solar cells for high illumination is being used to design cells for different concentration factors. It is shown that a cell design using one centimeter length grid fingers (w = 1 cm) can be made that would have an efficiency at 100 suns that is 90 percent of the efficiency of a typical cell at one sun. This may require about 30 fingers per centimeter and thus the deposition of the grid should be achievable with conventional techniques. These results were obtained by keeping the internal voltage drop constant by varying the internal resistance. The decrease in efficiency comes from the greater coverage of the surface with grids as the concentration increases. The importance of base material resistivity on cell design for high concentration is shown. One of the important parameters indicated on the first year's program was the dependence of the system cost for passively cooled arrays on the thermal conductance between cell and ambient air. Therefore a wind tunnel was constructed to measure these values in a controlled environment. The description of the heat rejection geometries being investigated in this tunnel is given. Typical results for the configurations tested to date are given. Calculations on additional concentration configurations are continuing and also the dependence of their characteristics on various design parameters. As a typical example it is shown how mirror surface inaccuracies affect the energy distribution incident at the cells. System cost studies are continuing.

9891 (JPL—5040-13, pp 279-296) **Photovoltaic applications of compound parabolic concentrator (CPC).** Winston, R. (Argonne National Lab., IL). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The objectives, tasks, and results of the program are outlined. The compound parabolic concentrator is sketched. Some cost and efficiency data are presented. (MHR)

9892 (JPL—5040-13, pp 310-329) **Development of low cost thin film polycrystalline silicon solar cells for terrestrial applications.** Chu, T.L. (Southern Methodist Univ., Dallas). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

Low-cost thin film polycrystalline silicon solar cells are being developed for terrestrial utilization. The technical approaches consist of (1) the deposition, characterization, and optimization of silicon

p-n junction structures on graphite and metallurgical silicon substrates, (2) the purification of metallurgical silicon, (3) the fabrication and characterization of solar cells from purified metallurgical silicon, and (4) the fabrication and characterization of large area cells, 30 cm^2 or larger in area. Progress is summarized briefly and data are presented.

9893 (JPL—5040-13, pp 330-353) **Glass-Si heterojunction solar cells.** Ahrons, R.W. (Syracuse Univ., NY). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The development of a low temperature, low-cost process to combine a wide band gap top surface material with silicon to form a heterojunction solar cell is proposed. The top material, in addition to forming a junction, provides an optically transparent window, low resistance contact, and an optical match for low reflectivity. The requirements for an overall low-cost array require, in addition to a low-cost process, a low cost substrate material such as polycrystalline silicon. An increase in efficiency was achieved on polycrystal silicon from an initial 2 percent to over 7 percent. The cells were produced in the 2 cm by 2 cm and 1 cm by 1 cm size, with top-side grid metallization. The polycrystalline silicon has crystal grains varying from 5μm to 5 mm. The junction is an n^+/n heterojunction between an SnO_2-based glass and the polycrystalline silicon. Voltages of up to 475 mV were measured under open circuit conditions. For single crystal substrates, efficiencies very close to 10 percent were measured. Short-circuit current density for single crystal approaches 30mA/cm^2 for the polycrystalline units; the short-circuit is about 90 percent of the short-current measured for the single crystal units. Work on p^+/n heterojunction using In_2O_3-based glass resulted in cells of 3 percent efficiency on polycrystalline material and 4 percent efficiency on single crystal material. Work on other glass/silicon systems did not show appreciable promise.

9894 (JPL—5040-13, pp 354-367) **Development of an economical silicon solar cell.** Lindmayer, J. (Solarex Corp., Rockville, MD). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

A method of growing electronically viable silicon films on inexpensive foreign substrates was investigated, with the objective of creating a technology to radically reduce the overall cost of the silicon employed in photovoltaic solar energy conversion. The approach employed is to enhance crystalline ordering during film nucleation by confining arriving silicon atoms to a narrow band traveling across a substrate, i.e., the Lateral Growth Technique (LGT). The efforts have employed physical vapor deposition of silicon in a vacuum evaporator on glass and metal substrates with both slit masks and single defining edges, and subsequent chemical vapor deposition (CVD) of thicker films on these thin film structures by pyrolysis of silane at higher temperatures. Efforts will continue on optimizing grain size and film-substrate compatibility for utilization of relatively conventional solar cell processing techniques and temperatures. The key results to date are: improved ordering with LGT, even using single-edge masking of the silicon flux and reasonable growth rates with the LGT-CVD combination.

9895 (JPL—5040-13, pp 368-386) **Epitaxial technology for low cost solar cells.** Kressel, H. (RCA Labs., Princeton, NJ); D'Aiello, R.V.; Robinson, P.H.; Raccah, P.; Pollack, F. 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

Epitaxial solar cell structures on low cost silicon substrates were studied as a means of improving the cell performance compared to direct diffusion into such substrates, and thus allow a wider use of these low cost materials to obtain useful solar cells. The primary emphasis is presently on the use of EFG ribbon material. Data obtained included the following: (1) comparative x-ray topograph of EFG ribbons (grown by Tyco-Mobil) and epitaxial layers deposited on these materials. (2) Study of diodes and solar cells fabricated by diffusion into the ribbon materials and epitaxially formed on the similar material. (3) Carrier concentration distribution studies of ribbon materials using electroreflectance data.

9896 (JPL—5040-13, pp 387-389) **Shallow junction photovoltaic device program.** Wichner, R. (Univ. of California, Livermore). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The objective to develop techniques to produce low cost, high efficiency solar cells, with emphasis on those processes which are applicable to the automated production of both single crystal and defect-laden ribbon or thin film polycrystalline solar cell material. Shallow junction devices are under primary consideration with several types of silicon solar cells having been fabricated, namely, (a) epitaxially-grown shallow junction cells, (b) Schottky-barrier cells, (c) Indium-Tin-Oxide on silicon cells and (d) cells produced by a unique process utilizing a corona discharge. Results with this latter process are described. Initial results in producing single crystal silicon solar cells were reported previously. Recent work has included the fabrication of polycrystalline silicon cells with AMl efficiencies of over 3 percent without an antireflection coating. Preliminary analysis of cells produced by the corona discharge technique indicates a profile of implanted ions which results in a low sheet resistance for the shallow rho-layer. Additionally, the presence of heavily-defected regions within a given cell does not seem to grossly affect the overall performance of the device.

9897 (JPL—5040-13, pp 400-403) **Assessment of the international workshop on CdS solar cells.** Boer, K.W. (Univ. of Delaware, Newark). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The International Workshop on CdS Solar Cells is described briefly. The points of agreement are summarized briefly under the following headings: initial performance and possible limits, cell reliability, economic factors, and general recommendations. (MHR)

9898 (JPL—5040-13, pp 404-415) **Very low cost thin film CdS—Cu_2S solar cell development using chemical spraying.** Samara, G.A. (Sandia Labs., Albuquerque, NM). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

A chemical spray process for the production of thin film CdS-Cu_2S solar cells projected to cost less than $60/kW in very large scale production was developed. The average efficiency of these cells has been improved from less than 0.3 percent to about 4.5 percent at present. The overall objectives of this program are to further develop the process, to raise the efficiency, and to attain long life stability. The cell consists of a glass substrate onto which is sprayed a thin tin oxide transparent electrode followed by a sprayed film (2 to 3 μm) of CdS. A very thin film of Cu/sub x/S is then formed by either spraying, dipping, or electrolytic ion exchange. Finally a copper/lead electrode is evaporated on top of Cu/sub x/S layer. The work on the limited number of available samples has consisted of a general survey of the potential usefulness of a wide variety of analytical techniques to the understanding of the structure, composition and properties of the films and devices. Preliminary findings are summarized.

9899 (JPL—5040-13, pp 416-441) **CdS thin film solar cells for terrestrial power.** Shirland, F.A. 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The facility for fabricating a modified design terrestrial cell was operated steadily. Cell outputs started out low (at 3.4 percent), dropped (to 2.0 percent) when closer controls were placed on the process, increased (to 3.4 percent) when a revised rinsing process was introduced, and increased further (to 5.0 percent average) when a revised barrier forming process was put into effect. Work continued on the development of a low cost grid system. Excellent evaporated metal grid patterns were obtained using a specially designed aperture mask. Real time roof top sunlight exposure tests of encapsulated CdS cells shows no loss in output after 5 months. Accelerated life testing of encapsulated cells shows no loss of output power after 6 months of 12 hour dark-12 hour AMl illumination cycles at 40°C, 60°C, 80°C and 100°C temperatures.

9900 (JPL—5040-13, pp 442-460) **Direct solar energy conversion for large scale terrestrial use.** Boer, K.W.; Meakin, J.D. (Univ. of Delaware, Newark). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The past and present activities and future plans are reviewed. The key results are reliable production technique was developed on low cost metallic substrates for large cells (55 cm^2) of mean efficiency approximately 5 percent and small cells (4 cm^2) of mean efficiency approximately 6 percent with the best cell 6.8 percent. Usable cell life in excess of 20 years was supported by roof-top and accelerated testing. Quantitative descriptions of short circuit current were developed with the role of CdS, Cu_2S and the interface region elucidated. The dominant role of interface recombination on V/sub oc/ was established. The structure of as-formed cell and effects of degrada-

tion was substantially established. Regeneration was accomplished by vacuum and hydrogen heat treatment.

9901 (JPL—5040-13, pp 462-474) **Reactively sputtered thin film photovoltaic devices.** Hsieh, E.J. (Univ. of California, Livermore). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

Thin film sputtering techniques were applied to form low cost thin film photovoltaic devices from materials with direct bandgap absorption characteristics used in existing single crystal solar cells. Cells have been made by the RF reactive sputtering of Cu in a hydrogen-sulfide and argon atmosphere to form Cu_2S layers on thermally evaporated CdS films. Over 40 cells were made by this new process; each exhibited a photovoltaic effect. The best observed efficiency so far, measured in sunlight, was slightly over 4 percent.

9902 (JPL—5040-13, pp 476-486) **Applied research on II—VI compound materials for heterojunction solar cells.** Bube, R.H. (Stanford Univ., CA). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

Heterojunction solar cells based on several II-VI compound systems suitable for large-scale terrestrial utilization are investigated. The three of greatest interest are p-CdTe/n-CdS, p-CdTe/n-ZnSe, and p-ZnTe/n-CdSe. The last of these three is of interest primarily as an opportunity to determine the effects of very small lattice mismatch rather than as an actual solar cell. A detailed program of heterojunction evaluation has been initiated, involving (1) J-V characteristics in the dark vs temperature to determine diode properties in the absence of illumination, (2) J-V characteristics in the light using the solar simulator, (3) V /sub oc/ vs ln J/sub sc/ as a function of light intensity at different temperatures to determine magnitudes and temperature dependence of key diode parameters, (4) junction capacitance vs voltage in light and dark, (5) SEM determination of minority carrier diffusion lengths, (6) optical transmission to determine exact variation of absorption constant with photon energy, and (7) spectral response of J/sub sc/ to determine dependence of quantum efficiency on photon energy.

9903 (JPL—5040-13, pp 487-498) **Investigation of thin film solar cells based on Cu_2S and ternary compounds such as $CuInS_2$.** Loferski, J.J. (Brown Univ., Providence). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The work is concerned with the production and characterization in film form of Cu_2S and related Cu compounds for photovoltaic cells. The low cost process technology being examined, namely the sulfurization method, is capable of producing films on various substrates. Cathodoluminescence is being used as a diagnostic tool (in conjunction with other aids such as x-rays, scanning electron microscopy, etc.) to identify Cu/sub x/S compounds. Cu_2S films have been prepared on silicon, cadmium sulfide, aluminum and silica. Diodes formed on single crystal CdS have reasonable I-V characteristics.

9904 (JPL—5040-13, pp 501-512) **Feasibility investigation of growing gallium arsenide single crystals in ribbon form.** Richardson, D.L. (Arthur D. Little, Inc., Cambridge, MA). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

A program was initiated to determine the feasibility of producing GaAs single crystal ribbons suitable for solar cell substrates. Constrained, encapsulated molten zones are passed through rectangular polycrystalline feed material to form single crystal ribbons. The objective is to grow 10 cm x 1 cm x 0.1 cm single crystals by a process that is amenable to continuous growth. Two methods have been used to establish passage of a molten zone through ribbon GaAs feedstock; direct coupling with rf to the GaAs and constrained zone-melting in B_2O_3 sealed graphite boats. Establishment of a narrow molten zone by direct rf coupling to GaAs was shown to be limited by the large skin depth required for heating GaAs as compared to the desired ribbon thickness.

9905 (JPL—5040-13, pp 513-532) **Exploratory study on microanalysis of thin films by backscattering techniques.** Mayer, J.W.; Nicolet, M.A. 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

To be potentially useful, SPEG (solid-phase epitaxial growth) layers must have controllable electrical characteristics, particularly with regards to conductivity type and resistivity value. Efforts were therefore undertaken to establish that such a control is possible. One processing step was added to the standard sample fabrication procedure by vacuum-depositing a thin layer (nominally 5A) of Sb before the deposition of the amorphous Si layer. Anneal steps remained unchanged. The resulting SPEG layer was analyzed in four different ways. The results apply to a typical sample obtained with initial layers of about 1000A Pd, 5A Sb and 1 μ of amorphous Si annealed in vacuum, first at 280° for 30 min and then under slowly increasing temperatures (greater than or equal to 0.2 °C/min) up to 525°C. The evidence that the layer is n type and well doped is convincing. To develop backscattering at energies below 1 MeV, depth calibration must be provided first by absolute measurements of stopping cross sections. Various methods of data evaluation and their errors were compared with computer programs tested against real ^4He spectra. All methods can attain a few percent, but values derived from films of known mass per unit area are generally most reliable. Summaries of main results, major problems, planned activity and renewal proposal are given.

9906 (JPL—5040-13, pp 533-546) **Low cost AMOS solar cell development.** Stirn, R.J. (Jet Propulsion Lab., Pasadena, CA). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

Recent developments have demonstrated that high conversion efficiencies are possible with GaAs metal-semiconductor solar cells when a particular heat treatment processing step is used to introduce an interfacial layer between the metal and the semiconductor. The new cell, called AMOS (Antireflection-Coated Metal-Oxide-Semiconductor), has open-circuit voltages of 0.68-0.72 volts and efficiencies of 15 percent under terrestrial sunlight, as compared to values of 0.45-0.48 volts and 10 percent, respectively, for similar cells without an interfacial layer. Potentially higher efficiencies are feasible as further improvements are made in optimizing the interfacial layer effect and in increasing the blue response of the cells. A program is described for investigating a thin film version of the AMOS solar cell which could better the economic goal of $0.50 per peak watt with an efficiency greater than 10 percent.

9907 (JPL—5040-13, pp 549-570) **Silicon Schottky photovoltaic diodes for solar energy conversion.** Anderson, W. (Rutgers—The State Univ., New Brunswick, NJ). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

Schottky barrier solar cells (SBSC) are fabricated on (100), 2 Ω-cm, p-type silicon using an Al ohmic contact, 50 A Cr and then 50 A Cu Schottky contact, Al current grid, and SiO antireflection coating. Past research was directed towards showing the potential of a SBSC in solar energy conversion. The present project is designed to improve understanding of the SBSC, improve efficiency to 12 percent, and evaluate potential towards thin film silicon applications. Progress in evaluating the variables in fabrication is summarized. Results of using "as-sawn" silicon and chemical polishing (only) to produce a smooth surface and the results of an activation energy study to explore current conduction mechanisms are shown. The most significant achievements have been increased fill factor (to 0.74) using baking of the vacuum system to remove moisture, improved understanding of the current flow mechanism, and isolation of processing variables which improve efficiency.

9908 (JPL—5040-13, pp 571-577) **Exploration of unconventional solar cells.** Grain, C.F. (Itek Corp., Lexington, MA). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

Research has been continued on a new concept for the production of low cost photovoltaic cells. The basic concept is that, rather than starting with an inherently high cost process and trying to reduce costs, one starts with a very low cost process for depositing particulate semiconductor layers involving emulsion coating techniques. It has been shown that the concept is feasible and in fact layers containing ZnO exhibited quantum efficiencies of greater than 50 percent and power efficiencies up to 3 percent with exposure to actinic light. Significant results have recently been obtained with other materials namely Pb_3O_4 and CdS. The spectral response characteristics of a typical cell are shown. Results have also been obtained with CdS-Cu_2O heterojunction cells. The I-V characteristics of a typical cell are shown. Continued efforts on both Pb_3O_4 Schottky barrier devices and CdS-Cu_2O heterojunction devices are planned.

9909 (JPL—5040-13, pp 578-590) **Process-induced defects in terrestrial solar cells.** Lindholm, F.A. (Univ. of Florida, Gainesville); Li, S.S.; Sah, C.T. 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The experimental effort concentrates on the fabrication of solar cells and related test devices, and on a detailed characterization of the current-voltage properties and of the defects that contribute to them. The experimental tools employed include: current-voltage measurement and transient-capacitance, thermally-stimulated-capacitance and thermally-stimulated-current measurements made on pn junction or Schottky-barrier test vehicles. To provide a quantitative illustration, a concrete example was taken: a phosphorous diffused n + p cell, junction depth 0.25 microns, impurity grade constant 10^{23} atoms/cm^4, substrate resistivity 0.1 ohm-cm. Further attention has centered on the measured open-circuit voltage at 300°K. To analyze this device, the traditional analytical theory of silicon solar cells was extended to enable inclusion of the high doping mechanisms. Of these mechanisms, it was concluded that gap shrinkage, taken alone in a one-dimensional model, falls far short of explaining the measured open-circuit voltage. To fit the data, a gap shrinkage of 0.23 eV would be required for impurity concentrations only slightly higher than 10^{18} cm^{-3}, which compares to our upper-bound estimate of 0.07 eV for such concentrations. From a physical standpoint, gap shrinkage was predicted to be small because minority carriers can exist in sizable numbers in the dark cell only where the doping is relatively small.

9910 (JPL—5040-13, pp 592-617) **Glass-Si heterojunction solar cells.** Anderson, R.L. (Syracuse Univ., NY). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

It is proposed to investigate glass/Si heterojunctions as solar cells of low cost, suitable for terrestrial applications. The Si is the active material, and the glass serves as a window to solar radiation, an antireflection coating of the Si, and a low resistance contact. Fabrication of the cell is simple and inexpensive. Principal specific goals of the project are (i) the fabrication of solar cells by deposition of various window materials on single and polycrystalline Si, (ii) experimental testing and evaluation of the cells, and (iii) the explanation of the characteristics by the development of suitable models. The concept of the heterojunction solar cell was shown to be valid in the form of an In_2O_3 window on p-type single crystalline Si. Experimental results showed the principal dark current mechanism in the operating range to be recombination through interface states, and the electron affinity of the In_2O_3 was found to be 0.3 eV greater than that of the Si. Investigations of other crystalline window materials have been initiated. Results of measurements on SnO_2/n-Si, single crystal, indicate an electron affinity difference relative to the Si of approximately 0.85 eV. Experiments with amorphous glasses such as $0.85V_2O_5 : 0.15P_2O_5$ show these materials to be impractical as solar cell windows.

9911 (JPL—5040-13, pp 618-629) **Surface science applied to the development of economical photovoltaic solar cells.** Siekhaus, W.J.; Somorjai, G.A. (Univ. of California, Berkeley). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

A surface potential model was developed to explain dopant effects on chemical vapor deposition. Auger analysis of the interaction between allotropic forms of carbon and silicon films has shown Si-C formation for forms of glassy carbon. LEED intensity measurements have been used to determine the mean square displacement of surface atoms of silicon single crystals, and electron loss spectroscopy has shown the effect of structure and impurities on surface states located within the band gap. A thin film of Al has been used to enhance film crystallinity at low temperature. (MHR)

9912 (JPL—5040-13, pp 630-638) **Dopant gas effect on silicon chemical vapor depositions. A surface potential model.** Chang, C.A. (Univ. of California, Berkeley). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

A surface potential model is proposed to consistently explain the known dopant gas effects on silicon chemical vapor deposition. This model predicts that the effects of the same dopant gases on the diamond deposition rate using methane and carbon tetrachloride should be opposite and similar to those of silane, respectively. Available data is in agreement with this prediction.

9913 (JPL—5040-13, pp 639-660) **Enhanced crystallinity of low temperature deposited silicon films on graphite substrates.** Chang, C.A.; Siekhaus, W.J. (Univ. of California, Berkeley). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The previously developed technique for silicon crystallinity enhancement in silicon films deposited at low temperature is applied to graphite substrates. The measured increase in silicon crystallinity is comparable to that observed earlier using a quartz substrate. The distribution of aluminum in the silicon films is determined using Auger spectroscopic depth profiling. Carbon diffusion from the substrate into the silicon film is shown to be negligible at a substrate temperature of 600°C.

9914 (JPL—5040-13, pp 661-676) **Cadmium stannate selective optical films for solar energy applications.** Haacke, G. 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

Efforts concentrated on reducing the electrical sheet resistance of sputtered cadmium stannate films, installing and testing equipment for spray coating experiments, and sputter deposition of thin cadmium sulfide layers onto cadmium stannate electrodes. In addition, ahead of schedule, single crystal silicon wafers were coated with cadmium stannate. Development of the backwall CdS solar cell continued.

9915 (JPL—5040-13, pp 677-695) **Ternary compound thin film solar cells.** Kazmerski, L.L. (Univ. of Maine, Orono). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The investigation of a group of ternary compound semiconductor (I-III-VI_2) thin films for future applications in photovoltaic devices is proposed. The consideration of these materials ($CuInSe_2$, $CuInTe_2$ and especially $CuInS_2$) for long-range device development is emphasized. Much of the activity to date has been concerned with the growth and properties of $CuInX_2$ films. X-ray and electron diffraction analyses, Hall mobility and coefficient, resistivity and carrier concentration variations with substrate and film temperature, as well as grain size data, have been determined. Both p- and n-type films of $CuInS_2$ and $CuInSe_2$ have been produced. Single and double source deposition techniques have been utilized. Some data have been recorded for annealed films. (e.g. $CuInS_2$ in H_2S/Ar). A tentative research schedule is included.

9916 (JPL—5040-13, pp 713-734) **Organic solar cell exploratory research.** Valenty, S.J. (General Electric Co., Schenectady, NY). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

This program is formulated to obtain an understanding of the principles governing the photovoltaic effect in organic materials on the molecular level, and to apply these principles to the design and fabrication of laboratory devices having a photovoltaic organic polymer film as their key element. The initial part of the program seeks to understand the mechanism of charge generation and separation in extremely thin (less than or equal to 50A) synthetic organic films, in which one side of the film is a light sensitive electron donor (or acceptor) and the other is an electron acceptor (or donor). Progress to date has been in three areas: (1) materials synthesis, (2) apparatus development, and (3) ultra-thin film fabrication. An initial materials synthesis has provided a variety of surface active dyes, primary electron acceptors and polymers needed as prerequisites to film fabrication. Apparatus development includes the design and construction of devices used: (1) to characterize the surface properties of materials at the air-water interface, (2) to fabricate the asymmetric ultra-thin films, (3) to observe the optical absorption and fluorescence spectra of the films, and (4) to measure the electrical properties of the films. Both symmetrical and asymmetrical ultra-thin films of the synthesized materials have been formed and supported on glass slides for optical study.

9917 (SAN/1202—77/2) **Thin films of gallium arsenide on low-cost substrates. Quarterly project report No. 3, January 2, 1977—April 2, 1977.** Ruth, R.P. Dapkus, P.D.; Dupuis, R.D.; Campbell, A.G.; Johnson, R.E.; Manasevit, H.M.; Moudy, L.A.; Yingling, R.D. (Rockwell International Corp., Anaheim, Calif. (USA). Electronic Devices Div.). Apr 1977. Contract EY-76-S-03-1202. 59p. Dep. NTIS, PC A04/MF A01.

The metallorganic chemical vapor deposition (MO-CVD) technique is being applied to the growth of thin films of GaAs and GaAlAs on inexpensive polycrystalline or amorphous substrate ma-

terials (glasses, glass-ceramics, alumina ceramics, and metals) for use in fabrication of large-area low-cost photovoltaic device structures. Polycrystalline GaAs films have now been grown on all of the low-cost materials on the candidate substrate list. Single-crystal films of GaAs and Ga/sub 1-x/Al/sub x/As(x approximately 0.8) have been grown to study the Zn and Se doping of these materials and to provide the doping data needed to grow p-n junctions and heterostructure solar cell configurations. The physical properties of GaAs films grown on a variety of substrates—including Mo/glass, Mo/alumina, and Ge layers on all of the candidate insulator materials—have been studied, and the results of these investigations are described. Single-crystal window-type heterostructure solar cells have been fabricated in GaAlAs/GaAs multilayer structures grown by the MO-CVD process. Results show that the MO-CVD process is capable of producing materials with the photovoltaic properties required for high-efficiency GaAlAs/GaAs solar cells. Polycrystalline solar cells have also been grown and fabricated. Various techniques for characterizing polycrystalline GaAs films have been developed further, and details of these studies are given. (WHK)

9918 (SAN/1288—3) **Thin films of gallium arsenide on low-cost substrates. Quarterly project report No. 3, April—June 1977.** Nelson, N.J.; James, L.W. (Varian Associates, Palo Alto, Calif. (USA)). Jul 1977. Contract EY-76-C-03-1288. 21p. Dep. NTIS, PC A02/MF A01.

The growth parameters for organometallic sourced GaAs using H_2S as the dopant were established. The material obtained was found to possess excellent electrical properties. The materials quality was not affected by the addition of $AsCl_3$ to the reactant stream during growth even though its presence profoundly affected the growth process. The added $AsCl_3$ increased the doping efficiency of H_2S and eliminated the thickness gradients from the grown layers. The added $AsCl_3$ also allowed for a reduction in growth temperature. Initial experiments with p-doping using DMZ have shown that p-type material can be produced as evidenced by the pn junctions formed. These junctions displayed light sensitivity and could be delineated by the SEM operated in the induced current mode.

9919 (SAND—77-0393) **Record of the photovoltaics power conditioning workshop.** Kroeger, F.R. (ed.). (Sandia Labs., Albuquerque, N.Mex. (USA)). Mar 1977. Contract EY-76-C-04-0789. 92p. (CONF-7610118—). Dep. NTIS, PC A05/MF A01.

From Photovoltaics power conditioning workshop; Albuquerque, New Mexico, USA (13 Oct 1976).

Separate abstracts were prepared for the six papers presented. (WHK)

9920 (SAND—77-0393, pp 6-17) **U. S. Photovoltaic Conversion Program.** Magid, L.M. (Energy Research and Development Administration, Washington, DC). Mar 1977.

From Photovoltaics power conditioning workshop; Albuquerque, New Mexico, USA (13 Oct 1976).

In Record of the photovoltaics power conditioning workshop.

The overall objective of the U.S. Photovoltaic Conversion Program within the Division of Solar Energy of the Energy Research and Development Administration (ERDA) is to develop low-cost reliable photovoltaic systems and to stimulate the creation of a viable industrial and commercial capability to produce and distribute these systems for widespread use in residential, commercial and governmental applications. To assist in achieving this goal, this program has the following specific objectives: (1) conduct research, development and demonstration to establish a factor of forty reduction in solar array prices (to $500/peak kWe) by 1986; (2) conduct a focused research and development effort on novel materials and devices to show the feasibility of a reduction in solar array prices of one hundred or greater (to $100 to $300/peak kWe) by 1986 and to establish the viability of this advanced technology by the year 2000; (3) develop concentration systems to demonstrate early low-cost electrical (and thermal) power generation systems; (4) continue systems and applications studies to further optimize the cost-effectiveness of photovoltaic energy conversion systems; and (5) conduct tests and demonstrations of governmental, residential, commerial, industrial and utility-type photovoltaic systems to establish their viability and stimulate their wide-scale acceptance. The program plan to achieve these objectives is described and the major ten-year planning milestones are identified.

9921 (SAND—77-0393, pp 18-22) **ERDA/Sandia Photovoltaic Systems Definition Project.** Schueler, D.G. (Sandia Labs., Albuquerque, NM). Mar 1977.

From Photovoltaics power conditioning workshop; Albuquerque, New Mexico, USA (13 Oct 1976).

In Record of the photovoltaics power conditioning workshop.

The ERDA Photovoltaic Systems Definition Project is aimed at identifying promising applications for terrestrial photovoltaic power systems and optimizing their performance and cost effectiveness. Various candidate applications and system concepts are currently being studied. This work will provide systems-related guidance to photovoltaic technology development by identifying critical system and subsystem performance and cost requirements.

9922 (SAND—77-0393, pp 23-53) **Photovoltaic cells and arrays.** Bickler, D.; Costogue, E. (Jet Propulsion Lab., Pasadena, CA). Mar 1977.

From Photovoltaics power conditioning workshop; Albuquerque, New Mexico, USA (13 Oct 1976).

In Record of the photovoltaics power conditioning workshop.

The design, operation, and performance of solar cells and solar cell arrays are described. The basic principles of silicon solar cells are analyzed with the aid of an equivalent circuit diagram. A short description of the types of solar cells made today and their most common failure mechanisms is included. The performance characteristics of solar arrays are discussed with emphasis on array current—voltage and impedance characteristics as well as the effects of degrading factors such as solar cell shadowing and fractured or damaged solar cells. Other topics of interest to the power conditioner designer include considerations for (1) array safety for terrestrial operational conditions, (2) array loading and electrical stability criteria, and (3) array power utilization. (WHK)

9923 (SAND—77-0393, pp 54-61) **Power conditioning systems.** Wood, P. (Westinghouse Electric Corp., Pittsburgh). Mar 1977.

From Photovoltaics power conditioning workshop; Albuquerque, New Mexico, USA (13 Oct 1976).

In Record of the photovoltaics power conditioning workshop.

Operation, circuit diagrams, and advantages and disadvantages of current-fed inverters and voltage-fed inverters for solar cell arrays are described. Also, load commutation and self-commutation for inverters are discussed and compared. Also, interfacing an electric battery storage system with a solar array—inverter system is briefly discussed. (WHK)

9924 (SAND—77-0393, pp 62-64) **Inverter technology: low power hardware.** Feltman, S.W. (Advance Conversion Devices Co., Passaic, NJ). Mar 1977.

From Photovoltaics power conditioning workshop; Albuquerque, New Mexico, USA (13 Oct 1976).

In Record of the photovoltaics power conditioning workshop.

Power inverter technology for lower power photovoltaic systems is discussed including complex systems with a supplemental power source and systems with storage available for excess power. Factors to be considered in designing power conditioning hardware for photovoltaic systems are outlined. (WHK)

9925 (SAND—77-0393, pp 66-82) **Utility interfacing.** Kornrumpf, W.P. (General Electric Co., Schenectady, NY). Mar 1977.

From Photovoltaics power conditioning workshop; Albuquerque, New Mexico, USA (13 Oct 1976).

In Record of the photovoltaics power conditioning workshop.

The area of utility interfacing is just one of the many requirements placed on a photovoltaic systems designer. Some of the system's requirements discussed are the residential loads to be driven by the system and the power envelope available from the array. The difference between these two power curves is the energy to be supplied to the utility as excess photovoltaic output. The manner this energy is supplied to the utility and the system problems created by this power flow are described briefly.

9926 **Solar battery.** Tsutomu, O. (to Kabushiki Kaisha Suwa Seikosha). US Patent 4,038,104. 26 Jul 1977. Priority date 9 Jun 1975, Japan. 6p.

A solar battery is manufactured by forming individual cells in a wafer, mounting the wafer on a substrate and separating the cells by the use of a thin saw. The channel thus formed between the cells is filled with an insulating material to prevent the accidental entry of stray material which might result in unwanted conduction between the cells. Preferably the insulating material between the cells is the same color as the cells in the interest of enhanced appearance. 7 claims, 7 figures.

BIOMASS PRODUCTION AND CONVERSION

9927 (BNL—21955) **Environmental critique of solar power by bioconversion methods.** Calef, C.E. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. Contract EY-76-C-02-0016. 21p. Dep. NTIS, PC A02/MF A01.

Idealistic approaches to the resolution of the energy crisis by increased usage of bioconversion methods are discussed. It is pointed out that shortcomings of the technology make such a goal unrealistic. Lack of land, water, and nutrients make a significant contribution to world energy needs impossible. Even modest application of bioconversion processes may damage valuable biotic communities

and other natural resources, especially soils. Data on minimum projected land, water, and nutrient requirements are presented; obvious generic impacts are discussed. (JGB)

9928 (CONF-7605161—, pp 1-5) **Solar energy for Australia. The role of biological conversion.** Morse, R.N.; Siemon, J.R. (CSIRO, Melbourne). 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

Solar energy by means of photosynthesis stores energy in trees and plants which can be converted to liquid fuel suitable for internal combustion engines. Ethanol could be produced this way from cellulose on a scale sufficient to supply half Australia's estimated needs for transportation in 2000 from forest plantations totalling 13 million ha. The process has been used on a small scale, but is not fully developed. Rising energy costs will improve the prospects that research could make solar ethanol competitive with synthetic fuels such as oil from coal, and introduce a major renewable source of liquid fuel.

9929 (CONF-7605161—, pp 6-10) **Biological conversion of solar energy: an assessment of its potential contribution to our energy requirements.** Boardman, N.K. (CSIRO, Canberra, Australia). 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

The global annual productivity of terrestrial and marine plants is equivalent to stored solar energy of 3×10^{21} J, which is 10-fold higher than present world consumption of energy. Solar energy incident on the earth's surface is 2×10^{24} J per annum. Total marine photosynthetic productivity is lower than that of the land. Maximum short-term growth rates of high yielding crops represent solar energy conversion efficiencies of 2.7 to 4.6%. Annual productivities are considerably lower (0.16 to 1.6%). Average forest productivities in the Northern Hemisphere represent solar energy conversion efficiencies of 0.2 to 0.3%. Indigenous forests in Australia have much lower productivities (0.02 to 0.03%). At the global level, it seems unlikely that photosynthesis can provide more than a relatively small percentage of the world's energy requirements. In Australia large areas of good agricultural land or productive forest would be required to produce a substantial fraction of our energy requirements.

9930 (CONF-7605161—, pp 11-15) **Efficient processing of photobiological material.** McCann, D.J.; Saddler, H.D.W.; Prince, R.G.H. (Univ. of Sydney). 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

The possibility of harnessing solar energy utilizing the photosynthetic mechanism of green plants to produce reduced carbon compounds for chemical processing to fuel has recently been advocated as one possible renewable energy source. Recent work is summarized; ways of utilizing this photobiological material are discussed, and the technical and economic implications of utilizing this source of solar energy in the most efficient manner are examined.

9931 (COO—2991-14) **Fuel gas production from animal waste: Phase I. Quarterly progress report (3rd), December 1, 1976—March 1, 1977. Dynatech report No. 1594.** Ashare, E.; Wentworth, R.L.; Wise, D.L.; Augenstein, D.C. (Dynatech R/D Co., Cambridge, Mass. (USA)). 15 Mar 1977. Contract EY-76-C-02-2991. 12p. Dep. NTIS, PC A02/MF A01.

A quarterly review meeting with ERDA contractors was held. The final draft was completed of the comprehensive engineering report on the engineering and economic analysis of fuel gas production from animal residue via anaerobic digestion. Several proposals were received from ERDA and reviewed.

9932 (COO/2917—3(Vol.2)) **Biological conversion of organic refuse to methane. Final report, July 1, 1973—November 30, 1976.** Quindry, G.E.; Liebman, J.C.; Pfeffer, J.T. (Illinois Univ., Urbana (USA). Dept. of Civil Engineering). Nov 1976. Contract EY-76-S-02-2917. 109p. Dep. NTIS, PC A06/MF A01.

In order to predict accurately the cost of producing methane from urban refuse, studies were initiated on the dewatering of the fermentor residue and the disposal of the residue from the system. Experimental procedures and data are reported in Volume I of this series; related computer programs and documentation are reported in Appendix C, bound separately as Volume II. This appendix contains detailed information on the simulation model. It is divided into five major sections; logic flow and notes, simulation results, definition of major program variables, program listing, and sample output. The section on simulation results includes an analysis of the system under various operating conditions. The program was implemented on the University of Illinois DEC-10 system. (JGB)

9933 (COO/4198—1) **Degradation of cellulosic biomass and its subsequent utilization for the production of chemical feedstocks. Progress report, December 1, 1976—February 28, 1977.** Wang, D.I.C.; Cooney, C.L.; Demain, A.L.; Gomez, R.F.; Sinskey, A.J. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nutrition and Food Science). May 1977. Contract EG-77-S-02-4198. 102p. Dep. NTIS, PC A06/MF A01.

The microbial degradation of cellulosic biomass has focused on the use of a thermophilic (55 to 60°C), anaerobic microorganism, Clostridium thermocellum. When this organism is grown with a crystalline cellulose, the cellulases produced are mainly extracellular. This same organism when grown on solka floc, high specific growth rates are exhibited as well as the ability to produce high concentrations of soluble reducing sugars. The rate of soluble sugar production appears to be growth associated. Studies on acrylic acid production are focused on two organisms: Peptostreptococcus elsdenii and Clostridium propionicum. An economic analysis on the acetone/butanol fermentation has been completed. The results show that continuous operation can reduce significantly the production cost compared to batch operation with the cost of raw material being major fractions for both processes. An increase in solvent concentration will effect substantial cost reduction. The production of acetic acid by Clostridium thermoaceticum has been shown to occur rapidly by this organism. Acetic acid concentration between 15 to 20 gm/liter have been achieved, corresponding to 86 percent of the theoretical maximum yield.

PHOTOCHEMICAL CONVERSION

9934 (CONF-760646—, pp 244-247) **Status of photoelectrochemical production of hydrogen and electrical energy.** Byvik, C.E.; Walker, G.H. (National Aeronautics and Space Administration, Hampton, VA). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

The efficiency for conversion of electromagnetic energy to chemical and electrical energy utilizing semiconductor single crystals as photoanodes in electrochemical cells has been investigated. Efficiencies as high as 20 percent have been achieved for the conversion of 330 nm radiation to chemical energy in the form of hydrogen by the photoelectrolysis of water in a $SrTiO_3$ based cell. The $SrTiO_3$ photoanodes have been shown to be stable in 9.5 M NaOH solutions for periods up to 48 hours. Efficiencies of 9 percent have been measured for the conversion of broadband visible radiation to hydrogen using n-type GaAs crystals as photoanodes. Crystals of GaAs coated with 500 nm of gold, silver, or tin for surface passivation showed no significant change in efficiency. By suppressing the production of hydrogen in a CDSe-based photogalvanic cell, an efficiency of 9 percent has been obtained in conversion of 633 nm light to electrical energy. A CdS-based photogalvanic cell produced a conversion efficiency of 5 percent for 500 nm radiation.

9935 (JPL—5040-13, pp 697-701) **Photochemical conversion of solar energy.** Berman, E.; Lichtin, N.N. (Boston Univ.). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

An examination of the kinetic and photochemical processes in the iron/thionine system coupled with optimization of cell performance has led to a 600 fold improvement in efficiency. At the same time, progress made in cell design points the way to potential inexpensive systems.

9936 (JPL—5040-13, pp 702-712) **Semiconductor-electrolyte photovoltaic energy converter.** Anderson, W.E.; Anderson, L.B. (Ohio State Univ., Columbus). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The goal of this work is the evaluation of the feasibility and practicality of a solar cell consisting of a semiconductor surface in contact with an electrolyte. Preliminary experimental and theoretical work, as well as a literature search, indicates the system merits further study. Specific semiconductor electrodes and promising electrolytes have been identified for further study. The basic components and processes for photovoltaic energy conversion at the surface of an n-type semiconductor in contact with an electrolyte which is oxidizing to conduction band electrons are shown. To date, characteristics of single crystal CdS, GaAs, CdSe, CdTe and thin film CdS in contact with aqueous and methanol based electrolytes were studied. Open circuit voltages were measured from Mott-Schottky plots and open circuit photovoltage. Short circuit current and quantum efficiency was measured as a function of lambda at low photon irradiances and as a function of photon irradiance up to 20 mW/cm^2.

Electrode corrosion as a function of current and electrolyte composition has been studied by drift of V/sub OC/ and I/sub SC/ with time, by microscopic examination of electrode surfaces and by electrochemical analysis of electrode decomposition products. The quantum efficiency for short circuit photo current of a CdS crystal and a 20 μm film and the electrical and photovoltaic properties are shown. The highest photon irradiances used were with the GaAs cell. Significantly higher conversion efficiencies were obtained with a different electrolyte and at low photon irradiances on GaAs. From an analysis of the short circuit current spectral response, it appears that a significant diffusion contribution to I/sub SC/ as well as the drift component due to photogeneration of carriers in the space charge region. Analytical methods suitable for detecting dissolution of CdS, CdSe, CdTe, and GaAs are being developed.

PHOTOVOLTAIC POWER PLANTS

REFER ALSO TO CITATION(S) 9877

9937 (CONF-7605161—, pp 139-143) **Solar power supply for remote rural consumers.** Darveniza, M. (Univ. of Queensland, St. Lucia, Australia). 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

Because of remoteness, a significant number of rural dwellings and properties in Queensland (and in other states) have little prospect of connection to public electricity supply. The most attractive alternative supply system is based on solar energy. Two systems of high reliability and low maintenance could be developed for this purpose, a combined thermal photovoltaic system or a small turbine-generator unit thermally powered by solar collectors. The requirements for the application of such systems to the supply of rural consumers are considered in this paper, and it is shown that a research and development program would cost about $30 to $60 per potential consumer.

9938 (JPL—5040-13, pp 2-21) **National photovoltaic conversion program.** Magid, L.M. (Energy Research and Development Administration, Washington, DC). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

The ERDA role in the National Photovoltaic Conversion Program is outlined. The ERDA organization chart with respect to the solar program is given; and the objectives, program structure, program plan, and utilization plan are discussed. (WHK)

9939 (JPL—5040-13, pp 232-249) **Status of ERDA-DOD applications plans.** Dinger, D.B. (Army Mobility Equipment Research and Development Center, Fort Belvoir, VA). 1975.

From National solar photovoltaic program review meeting; Los Angeles, California, USA (22 Jul 1975).

In Proceedings of the first ERDA semiannual solar photovoltaic conversion program conference.

A one month DOD study sponsored by ERDA is reviewed briefly. The objective is to produce a demonstration program which will define the role of Solar Terrestrial Photovoltaic (PV) systems as power sources for DOD applications. Pótential applications of PV power sources were identified and evaluation criteria were developed. Program information is outlined. (MHR)

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 9937, 10563

OCEAN THERMAL GRADIENT POWER PLANTS

9940 (ORNL/MIT—251) **Evaluation of ammonia evaporators for an Ocean Thermal Energy Conversion System.** Hossan, R.J. Jr.; Duret, G.L.; Yeung, J.C. (Oak Ridge National Lab., Tenn. (USA)). 22 Mar 1977. Contract W-7405-ENG-26. 65p. Dep. NTIS, PC A04/MF A01.

Designs for shell and tube and plate and fin evaporators were investigated with computer simulation and optimization programs. The evaporators were designed to deliver 1657 lb/sec of ammonia vapor at 73°F and 136 psia to a turbogenerator for 28 MW(e). Based on this requirement, a shell and tube evaporator constructed from aluminum requires less material than a plate and fin evaporator when plate and fin thicknesses are restricted to 0.02 and 0.01 in., respectively. The optimum shell and tube design provides 8.45 kW/ft^3 of aluminum and contains 94,900, 18-ft tubes of 1.27-in.-ID.

9941 **Pump starting system for sea thermal power plant.** Anderson, J.H. (to Sea Solar Power, Inc.). US Patent 4,030,301. 21 Jun 1977. Filed date 24 Jun 1976. 4p.

In a turbine driven power generating plant of the type using for example a hydrocarbon or halocarbon as the working fluid operating on or near the surface of an ocean, warm surface water is used as a source of heat for a boiler and cold water pumped from substantial depths is used to condense the working fluid after it has been expanded through the turbine. An auxiliary power source for starting the water pumps of the main system includes a prime mover driving a compressor which in turn supplies a high energy working fluid to a turbine coupled to drive the water pumps. The turbine exhaust after being cooled in a heat exchanger by the cold water pumped from the ocean depths, is returned to the suction side of the compressor.

SOLAR RADIATION UTILIZATION

REFER ALSO TO CITATION(S) 10609, 11209

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 10612

9942 (CONF-7605161—, pp 25-29) **Open-cycle solar energy cooling systems.** Close, D.J.; Dunkle, R.V. (James Cook Univ. of North Queensland, Townsville, Australia). 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

One basic method for using solar energy for cooling air conditioning employs an air/water vapour mixture as the working fluid, the air being dehumidified, cooled and evaporatively cooled in appropriate devices so that its state when entering a building is such that the building interior state is acceptable for human thermal comfort. This paper proposes two psychrometric cycles which, by making use of an improved understanding of adsorption processes in packed beds, are less complex than cycles previously studied. Estimates are made of component sizes for a system cooling a house in Darwin.

9943 (COO/2939—1) **Solar space heating systems using annual heat storage. Progress report, July 1, 1976—December 31, 1976.** Hooper, F.C.; Attwater, C.R. (Toronto Univ., Ontario (Canada). Dept. of Mechanical Engineering). Apr 1977. Contract EY-76-C-02-2939. 99p. Dep. NTIS, PC A05/MF A01.

The assumptions made in the development of the computer simulation used for modelling annual storage solar heating systems are outlined. A vertical cylindrical storage tank is used with homogeneous soil properties and a water table and ground surface acting as sinks. The equations used are described in a general way. Report work done under the grant to date and approaches used to find optimum configuration is also included.

9944 **Solar heating system and panels.** Bakun, P.; Porter, C. US Patent 4,037,583. 26 Jul 1977. Filed date 21 Jul 1975. 10p.

A solar heating system is provided in which is employed a source of a heatable fluid and an arrangement of solar heating panels to receive heat from the sun and heat the fluid. A heat sink is provided to receive the fluid from the solar panels and to store heat received with the fluid. A heat transfer arrangement transfers heat from the heat sink to a heating system medium. The heat sink includes a tank which is connected in a closed loop with the solar heating panels to receive heatable fluid from the panels. Aggregate is provided in the tank to store heat received via the heatable fluid. The heat transfer arrangement includes a duct for the passage of air and rocks arranged in the duct for storing heat received from the tank. In one construction, the panels each comprise an array of tubes of a heat conductive material and a heatable mass in which the array is located and heated in order to heat fluid flowing through the tubes. The heatable mass may include a dark colored concrete in which are embedded sheets of screening which sandwich the tubes therebetween. Another construction includes spaced corrugated metal sheets which form an envelope which is fed by tubes attached to the top and which drain at the base. The envelope may also be made up of flattened tubes which would compartmentalize each corrugation. 11 claims, 6 figures.

9945 **Solar energy conversion plant.** Parham, J.P. US Patent 4,031,879. 28 Jun 1977. Filed date 28 Oct 1975. 6p.

A solar heating plant incorporating means to condense and focus solar energy on an elongated heat exchange member which is in communication with a fluid which is circulated thru a thermal storage means to heating radiators is described. An alternate embodiment is disclosed wherein the heating fluid is water and the system provides hot water for general purpose use in addition to hot water for the radiating elements. 7 claims, 12 figures.

9946 **Heat pumps with solar heat source.** Wallin, M.; Shantzer, A. (to Shantzer-Wallin Corp.). US Patent 4,030,312. 21 Jun 1977. Filed date 7 Apr 1976. 12p.

A reversible compression type refrigeration system is commonly known as a heat pump for conditioning a space having a conditioning side and a service side. The conditioning side is that area or environment where it is intended to achieve the benefit of the alternate heating and cooling effects produced by the reversible system. The service side is that side from which heat is drawn or to which heat is rejected when the opposite effect is required on the conditioned side. The system includes a conditioning coil connected to the conditioning side for absorbing heat from the space when cooling is required (cooling cycle) and rejecting heat to the space when heating is required (heating cycle); a first "service" coil connected to the service side adapted to reject heat to the outdoor air during system cooling cycles and absorb heat from the outdoor air on heating cycles; a second "service" coil connected to the service side adapted to withdraw direct or stored heat from a liquid stream heated by a solar collector, and reversible means to allow the first service coil to withdraw heat from the outside air under conditions where the supply of direct or stored solar heat intended to be delivered to the second service coil has been exhausted. 13 claims, 6 figures.

9947 **Heat and cold storage apparatus.** Thomason, H.E.; Thomason, H.J.L. Jr. US Patent 4,029,082. 14 Jun 1977. Filed date 19 Jun 1974. 4p.

Solar heat storage apparatus, invented by Thomason, includes a tank of water surrounded by a truckload of stones in a heat storage bin in the basement, U.S. Pat. No. 3,254,702 and others. Air circulating through the bin is warmed and circulated through the home to warm the home, or other building. The present invention adds humidity to the air and also enhances heat transfer out of the storage bin and into the home by heat-of-vaporization. That permits use of heat from storage to a lower temperature level while making the home feel warmer. And, the solar heat collector obtains more free heat from the sun because it is operating at a lower temperature level and more efficiently. Heat that normally goes up the chimney from an auxiliary heat source, such as a water heater or furnace, is used to assist home heating.

9948 **Solar energy transport system.** Strong, J.D. US Patent 4,029,081. 14 Jun 1977. Filed date 14 Nov 1975. 8p.

A solar energy collector comprises a heat conducting sheet having a front surface exposed to the sun and a system of liquid-receiving open-top troughs projecting from the back surface into an air space, with liquid supply means delivering liquid to the troughs and drain means receiving any liquid overflowing the troughs. Inlet and outlet air conduits communicate with the air space, and a blower causes a flow of air from the inlet conduit, through the air space, and to the outlet conduit; whereby the heat of vaporization of any liquid vaporized is transferred from the sheet to the outlet air conduit in addition to the heat transferred by the sensible temperature rise of the air and the vapor. Also disclosed are a heat storage unit, for use with such an energy collector, in which the heat storage medium may be stones, water, or it may be formed from Glauber's Salt, and a complete solar energy utilization system comprising such a collector, such a heat storage unit, and a heat exchanger (e.g., a radiator or convector in a living space) with controls and valves for (1) delivering heat from the sheet to the storage unit, (2) delivering heat from the sheet to the heat exchanger, or (3) delivering heat from the storage unit to the heat exchanger. 12 claims, 7 figures.

9949 **Solar panel.** Granger, F.R.; Granger, M.G. US Patent 4,027,447. 7 Jun 1977. Filed date 1 Jul 1976. 4p.

A panel structure mounted on the roof of a building is described for permitting solar energy to pass therethrough into the building. The panel structure includes a first translucent panel having corrugations running in a first direction. A second translucent panel is placed on top of the first translucent panel with the corrugations running perpendicular thereto. The two panels are secured together and sealing members are interposed between the first and second panels. Upper surfaces of the sealing members are complementary in shape with the corrugations for mating with the upper panel and producing a seal between the panels along two edges thereof. A second sealing strip seals the other two edges of the panels. Thus, a structurally strong and lightweight panel is produced that can be readily mounted on a roof.

9950 **Solar heating system.** Taylor, M.F. US Patent 4,016,861. 12 Apr 1977. Filed date 2 Jul 1975. 6p.

A solar heat collector is formed by a unitary top plate having spaced apart downwardly extending tabs, a unitary bottom plate having spaced apart upwardly extending tabs, a frame holding the plates together in spaced apart relationship with the tabs intermeshed, and a backing plate held in the frame under the bottom plate. The upper surfaces of all plates and tabs are painted black to better absorb solar heat. Air is circulated between the heat collector and a porous heat storage unit to transfer heat from the collector to the storage unit, the tabs of the heat collector serving both as heat absorbent surfaces and as baffles to maximize heat transfer from the heat collector to the air stream. The tabs can be formed by making a plurality of H-shaped cuts in the top and bottom plates and then bending the inner margins of each H-shaped cut away from the plane of the corresponding plate to form two tabs. A looped water conduit can be mounted on staggered supporting panels within the heat storage unit, the staggered supporting panels acting as baffles to maximize air stream contact with the looped conduit to thus maximize heat transfer to the water therein. 9 claims, 10 figures.

WATER HEATING

REFER ALSO TO CITATION(S) 9945, 9950, 9966, 9969

9951 **Water heating assembly.** Bouse, C.W. (to General Energy Devices). US Patent 4,036,207. 19 Jul 1977. Filed date 11 Dec 1975. 8p.

A solar water heating assembly is described utilizing a heat collector in a fluid communication and water delivery to and from a primary and/or auxiliary water storage tank. The heat collector unit includes a collector plate mounted within an insulated casing and includes water filled conduit integrally formed thereon and disposed in fluid communication with a primary heater conduit assembly having a plurality of heat collector elements mounted in predetermined relation thereon so as to initiate heating of the water or liquid entering the tubing wherein heat is gathered from the interior of the casing in which the tubing and primary heating unit are both mounted. The primary heater conduit is disposed in insulated relation to the collector unit wherein the collector unit is mounted in spaced relation to the bottom of the casing. A heat sensing element is mounted on the assembly in temperature gauging relation to the water passing therethrough and further being electrically connected to a pump element which forces water circulation between the heat collector unit and the primary and/or auxiliary water storage tank. 15 claims, 7 figures.

9952 **Solar water heater.** Vroom, H.J.; Bolle, W.R.; Schneider, H.; Swerdling, B. (to Grumman Aerospace Corp.). US Patent 4,015,586. 5 Apr 1977. Filed date 12 Jan 1976. 6p.

A closed water/glycol solar heating system is described for preheating a fluid so as to reduce energy requirements in bringing said fluid up to a desired temperature and holding same, said system including a solar collector having a flexible dome.

OTHER

9953 **Solar energy device.** Newland, E.L. US Patent 4,033,126. 5 Jul 1977. Filed date 9 Apr 1975. 4p.

A solar energy powered hot air turbine is described comprising a heat collector having an air inlet and outlet with the turbine connected to the air inlet. The heat collector is heated by solar energy and is constructed so that the hot air exhausts through the air outlet thus sucking air in through the air inlet to power the turbine. 7 claims, 2 figures.

9954 **Open cycle solar energy system utilizing buoyancy as a conversion force.** Shaw, J.B. US Patent 4,028,893. 14 Jun 1977. Filed date 3 Apr 1975. 10p.

An open cycle energy conversion system is described adaptable for use with, inter alia, solar collectors and other sources of available heat for increasing the temperature of a moving gas and employing a substantially vertically positioned gas expanding column comprising an endless arrangement of cups journaled for movement in a closed path in a liquid medium in the column for trapping the heated gas inside a succession of the cups inverted at the bottom of the column and displacing at least a part of the liquid in the cups, thereby providing a buoyancy force on the cups causing them to rise in the column exerting a rotating force on the endless arrangement of cups. The trapped gas is released at the top of the liquid in the column to be exhausted to atmosphere.

9955 **Engine powered by low boiling liquid.** Gulko, A.G. US Patent 4,012,911. 22 Mar 1977. Filed date 23 Mar 1976. 4p.

An engine powered by low boiling liquid and adapted to operate upon partial immersion in a heated liquid, which may be solar heated, is provided by a circular train of tubular compartments in which adjacent compartments are sealed to interconnectors and the train is tied to a central axle so that rotation of the train will rotate the axle. The interconnectors have an opening and a tube extending forwardly into the leading compartment, and one way valves permit rearward movement through the tube while preventing forward movement through the tube, and this allows liquid in the bottom compartment to be pumped rearwardly to a descending compartment to power the engine while liquid in an ascending compartment drains rearwardly to minimize the drag on the engine. 7 claims, 3 figures.

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 9890, 9891

9956 (CONF-7605161—, pp 40-45) **Testing of flat-plate solar collectors.** Cooper, P.I. (CSIRO, Melbourne). 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

A method of testing is presented to experimentally determine the thermal performance characteristic of a flat-plate solar collector, using an outdoors experimental facility. A nonlinear model of the variation of efficiency with temperature difference at a given radiation level has been used as the basis for deriving the performance characteristic from experimental data points. The layout and operation of the experimental rig is described and the results on two collectors are presented. The coefficients of the derived nonlinear performance characteristics are compared and found to agree with the values calculated from laboratory tests on the collectors. The daily efficiencies computed from both nonlinear and linear thermal performance characteristics are compared, using three dimensionless parameters to describe the daily operation of a collector when subjected to a parabolic radiation function. It is concluded that in many circumstances the difference in efficiency is only marginal, but it is recommended that a nonlinear model be used for computer simulation purposes.

9957 (COO/2597—3) **Studies on methods of reducing heat losses from flat plate solar collectors, Phase 2. Annual progress report, February 1, 1976—January 1, 1977.** Hollands, K.G.T.; Raithby, G.D.; Unny, T.E. (Waterloo Univ., Ontario (Canada). Research Inst.). Jan 1977. Contract EY-76-C-02-2597. 44p. NTIS $4.00.

Improvements to flat plate solar collectors for heating and cooling of buildings are being investigated through two parallel studies. The first study, which deals with the free convective heat loss from V-corrugated absorber plate to a plane glass cover, has shown that, for the same average spacing, the free convective heat loss is greater for a V-corrugated absorber plate than for a plane absorber plate. However, provided the average spacing is large enough, the amount of increase is slight. The second study, which deals with the free convective heat loss in a honeycomb solar collector in which the honeycomb consists of a set of horizontal partitions, or slits, has shown that provided the solar collector is tilted to near vertical, such a honeycomb gives better free convective loss suppression than does a square-celled honeycomb having the same amount of material.

9958 **Solar energy collector apparatus.** Orrison, W.W. US Patent 4,038,972. 2 Aug 1977. Filed date 29 Mar 1976. 8p.

The present invention includes a solar energy collector for concentrating the sun's rays on a conduit having a fluid flowing therethrough. A primary reflector is oriented in a north-south direction. The sun's rays are reflected from the primary reflector to a smaller secondary reflector located thereabove, which further reflects the sun's rays onto a conduit recessed below the primary reflector. The concentrated sun's rays on the conduit heats the conduit. The heated conduit further heats a fluid flowing through the conduit. The heated fluid is used to generate energy, directly or indirectly. An automatic control device, including a light sensor, continually adjusts the primary and secondary reflectors to insure that the sun's rays are striking the primary reflector at the proper angle. Adjustments of the primary and secondary reflectors are made by pivotal movement about the conduit which does not move. 14 claims, 5 figures.

9959 **Solar heat storage system.** Brugger, H. US Patent 4,037,652. 26 Jul 1977. Filed date 30 Jan 1976. 8p.

A solar heat storage system is described including in combination a liquid vessel for storing solar energy and solar heat collection means comprising a network of serially connected conductive conduits arranged in a serpentine fashion and coupled to a source of antifreeze in a closed loop, said plurality of conduits lying below street level and covered by a layer of blacktop. 7 claims, 5 figures.

9960 **Selective solar energy absorption.** Straub, J.F. (to E.I. DuPont de Nemours and Co.). US Patent 4,036,206. 19 Jul 1977. Filed date 30 Jul 1976. 8p.

Superior solar energy absorption selectivity is found with blackened white brass electroplated surfaces in which the white brass contains 0.5 to 20 percent by weight copper, balanced zinc, which has been electroplated using certain brighteners such as 1-benzl pyridinium, 3-carboxylate and then blackened with a weak solution of nitric acid. 10 claims.

9961 **Solar energy system.** Waldrip, R.L. US Patent 4,034,735. 12 Jul 1977. Filed date 4 Feb 1976. 20p.

A system for collecting solar energy consists of a target for absorbing solar radiation positioned above a plurality of independently positionable reflectors, each reflector including a base, a concave circular reflecting surface, and means responsive to incident solar radiation for positioning the reflector with respect to the target and the sun such that solar radiation incident upon the reflectors will be directed toward the target. The system can also include means for initiating the positioning of the reflectors only in response to the presence of the sun above a predetermined minimum angle with respect to the horizon. 16 claims, 4 figures.

9962 **Solar heating method and apparatus.** Telkes, M. (to Univ. of Delaware). US Patent 4,034,736. 12 Jul 1977. Filed date 11 Dec 1974. 10p.

A solar air heater is vertically disposed and composed of a plurality of parallel, horizontally disposed slats resembling a venetian blind. The slats are positioned with their upper faces facing the sun and at an acute angle relative to the horizontal such that the winter sun will produce multiple heat absorbing reflections between adjacent slat surfaces, whereas the summer sun will be reflected back, if desired, so as to impart little or no heat to the heater. Air is circulated through the heater between the slats, thereby becoming heated as it absorbs heat from the slats. This heated air is then sent into a structure, such as a room of a house, via air ducts or the like to heat the structure or is sent to such other areas as desired, the solar air heater being attached to or forming a part of the structure that is to receive the heat produced by its use. 30 claims, 16 figures.

9963 **Mass flow solar energy receiver.** Powell, W.R. US Patent 4,033,118. 5 Jul 1977. Filed date 19 Aug 1974. 18p.

A receiver is described for collecting solar energy at high temperatures with low reradiation losses. The invention comprises in a preferred embodiment an insulated cavity absorber wherein a temperature gradient exists from the receiving end of the absorber toward the closed end thereof. The closed end exists at a higher temperature than the receiving end due to the cooling effect of a flow of fluid directed into contact with the walls of the absorber from the receiving end toward the closed end, the fluid being additionally utilized to extract heat from the absorber for utilization thereof. 18 claims, 6 figures.

9964 **Fluid sheet solar collector.** Walker, J.E. US Patent 4,033,325. 5 Jul 1977. Filed date 11 May 1976. 14p.

This fluid sheet solar collector is devised as an assembly to produce a sealed unit which contains an internal collector fluid circulating through a closed loop to pass in a thin sheet over a solar energy absorber surface and to pass in good thermal contact through a self contained heat exchanger to effect a net solar energy derived heat transfer to external devices. The internal collector fluid flows upward in a thin sheet contained between a semi-rigid transparent cover and a solar absorber surface wherein the fluid is heated; and flows downward through a heat exchanger wherein the heat is transferred, the net effect is to maintain a thermokinetic circulation of the fluid with neither fluid conduits nor high thermal conductivity materials required in the heating portion of the assembly. 8 claims, 3 figures.

9965 **Solar heat collector.** Eckels, R.E. US Patent 4,033,324. 5 Jul 1977. Filed date 10 Mar 1975. 6p.

A plurality of focusing elements, mounted above a solar radiation absorbing substrate, focuses solar energy rays into a series of hot spots on the substrate, providing a high temperature for a heat transfer medium. 6 claims, 14 figures.

9966 **Inflatable solar collector for swimming pool.** Leitner, L.J. US Patent 4,033,326. 5 Jul 1977. Filed date 23 Feb 1976. 4p.

An inflatable solar collector is described for heating a swimming pool comprising: a plurality of individual solar heating sections; each of the sections having an upper portion which is transparent or translucent and a lower portion having an internal surface which absorbs solar energy, the lower portion being connected to the upper portion to provide a substantially enclosed intermediate dead air space; the sections having a major plane which is substantially parallel to the surface of the water in the pool when the collector is floating on the water; when inflated, the upper portions intersecting the plane at at least two locations such that the angles formed by the intersections of the upper surface with the plane is about 40° to 70°; a plurality of tabs interconnecting the sections and providing air passageways therebetween; and inflating means to permit the sections to become inflatable by gas pressure, the collector being floatable on the water surface when inflated. 10 claims, 5 figures.

9967 **Solar energy collector module system.** Pei, Y.K. (to Owens-Illinois, Inc.). US Patent 4,033,327. 5 Jul 1977. Filed date 24 Nov 1975. 12p.

The invention disclosed is a solar energy collector apparatus having several double-wall glass tubular elements connected on opposite sides of an elongated manifold to form a module. The elements are sealed in oppositely facing metal cups and inside the opposite elements is a cross supply tube. The cups in a module are

series connected by conduits for flow of a liquid through the collectors. Along the manifold are two header pipes respectively connected to the cups for introducing liquid to the collectors for series flow and for receiving heated liquid flowed through them. The headers also connect a series of modules and the system utilizing the solar heated liquid. The cups, header pipes and interconnecting conduits are enclosed in an insulation jacket of foamed plastic, e.g., polyurethane. The manifold includes support brackets for mounting the apparatus in spaced drainage position above a supporting surface having a solar exposure. The outer ends of the tubular collectors are supported on an end loading device which firmly supports the element above the support surface and retains the element in its manifold cup when under hydraulic pressure.

9968 Method and device for collecting solar energy. Devin, B. (to Commissariat a l'Energie Atomique). US Patent 4,031,880. 28 Jun 1977. Priority date 21 Apr 1975, France. 4p.

In a system of stationary collectors which are connected together in series and differently oriented with respect to the sun, a heat-transporting fluid is circulated from the collector which is least exposed to solar radiation to the collector which is the most exposed to solar radiation. The direction of flow within the collectors is reversed at a moment of the day which is determined beforehand so as to control the quantity of energy delivered by the collectors. 9 claims, 4 figures.

9969 Solar heater. Thiel, H.E.P. US Patent 4,031,881. 28 Jun 1977. Filed date 20 Oct 1975. 4p.

A solar heater has metal pipes arranged in an array connected to carry liquid which will be heated by heat received from solar radiation transmitted through the pipe walls. The pipes are formed from sheet metal so that their internal and external reflectivity may be controlled. The pipes are provided with a dark exterior on the side which will face the sun. 2 claims, 3 figures.

9970 Solar collector control system. Beck, E.J. Jr. (to Secretary of the Navy). US Patent 4,031,444. 21 Jun 1977. Filed date 20 Oct 1975. 4p.

A system is described for controlling the movement in azimuth and elevation of a large number of sun following solar energy collectors from a single central controller. The system utilizes servo signal generators, a modulator and a demodulator for transmitting the servo signals, and stepping motors for controlling remotely located solar collectors. The system allows precise tracking of the sun by a series of solar collectors without the necessity or expense of individualized solar trackers. 7 claims, 2 figures.

9971 Solar tracking device. Zerlaut, G.A.; Heiskell, R.F. (to Desert Sunshine Exposure Tests, Inc.). US Patent 4,031,385. 21 Jun 1977. Filed date 5 Apr 1976. 6p.

A solar tracking system is disclosed, utilizing a photovoltaic device, for following the changing solar position. When the sun ceases to be the brightest object in the sky, such as during periods of partial cloud cover, and the system seeks to acquire the brightest spot in preference to the sun, the photovoltaic device is automatically overridden. The override system is clockdriven and moves the tracking system to approximate the solar position so that the sun can be immediately reacquired by the photovoltaic device when the sun re-energizes as the brightest object in the sky. 6 claims, 1 figure.

9972 Solar energy collectors. Beaver, E.R. Jr. US Patent 4,030,478. 21 Jun 1977. Filed date 15 Apr 1976. 4p.

An apparatus is described comprised of a novel and efficacious arrangement of state-of-the-art materials resulting in substantial advantages in both efficacy and, especially, economy over presently known solar collectors. The invention is characterized by a closed, circuitous, solar energy absorbing pathway of especially designed profile in which water or other suitable fluid media is caused to circulate while absorbing solar thermal energy. 4 claims, 4 figures.

9973 Solar energy collector. Gorniak, J. US Patent 4,029,077. 14 Jun 1977. Filed date 13 Jun 1975. 4p.

A solar collector is described having a hollow, pyrimidical-shaped body made of insulation material and a fluid conducting coil of tubing extending around the inside of the body. A plurality of sheets of rigid material support alternate layers of liquid and of lenses which focus sunlight onto the liquid and onto the coils of tubing thereby heating the liquid. The liquid in the coils is connected in series with the liquid supported on the sheets so that liquid can be withdrawn from the ends of the coils and passed through a battery for storing the heat or otherwise supported and stored. The collector also includes an infrared absorber. 12 claims, 10 figures.

9974 Thermal collector of solar energy adapted for high temperature operation. Warren, R.W. (to Westinghouse Electric Corp.). US Patent 4,029,080. 14 Jun 1977. Filed date 27 Jan 1975. 14p.

A thermal collector of solar energy that is adapted for installation in the roof structure of a building includes a cover plate to transmit sunlight, a backing, and an energy-absorbing material carried by the backing, to absorb energy of the transmitted sunlight and to transfer heat of such absorbed energy to the backing. A heat transfer medium delivers heat from the backing to a heat using apparatus such as a building heating or air conditioning system or a heat pump. The backing is designed to limit the weight of the collector and to improve its rate of thermal response upon reappearance of the sunlight. For purposes of limiting heat losses from the backing to the cover plate, the collector is evacuated and components that connect the backing with the cover plate are designed for low heat flow. Thus heat is delivered to the heat using apparatus at an elevated temperature of the heat transfer medium for improved efficiency of such apparatus. 15 claims, 9 figures.

9975 PBS-AL selective solar absorber. McMahon, T.J.; Green, A.K. (to Secretary of the Navy). US Patent 4,029,853. 14 Jun 1977. Filed date 20 Jun 1975. 4p.

A solar absorber is described comprising a 1000 to 1500 A thick layer of lead sulfide on a thermally conductive base. The solar absorber reflects on the order of 97% of the infrared while absorbing between 90 and 95% of the solar radiation band. 2 claims, 2 figures.

9976 Solar energy collector. Groth, G.F. (to Sun Unlimited Research Corp.). US Patent 4,029,258. 14 Jun 1977. Filed date 14 Nov 1975. 4p.

A metal collector plate with black paint on its face is mounted in a heat insulated space with a dual pane transparent member transmitting solar rays to the face of the plate. The front face of the plate is spaced from the transparent member providing a passage for free flow of air upwardly along the painted surface. The back side of the plate is divided transversely for exposure to two air chambers, the lower air chamber receiving incoming cool air which becomes pre-heated by contact with the back side and then flows through suitable passages through the lower edge of the plate into the free flow passage, and the upper air chamber receiving heated air from the free flow passage through slots at the upper edge of the plate and additionally providing for contact between the heated air and the back side of the plate. A differential thermostat control for flow of air through the collector unit is operated by heat sensor probes in the cold air intake and hot air chamber. 10 claims, 3 figures.

9977 Solar collector coating. Schmidt, F.J. (to Ametek, Inc.). US Patent 4,026,271. 31 May 1977. Filed date 19 May 1976. 6p.

A solar heat collector is described including a panel having a coating of PbO_2 electrodeposited from a tartrate bath and a second coating of oxygen-deficient PbO_2, such as α-PbO_2 or β-PbO_2, heat being absorbable thereby and transferable to a liquid or gas for operating heating or cooling system. 6 claims, 2 figures.

9978 Solar collector. Bottum, E.W. US Patent 4,026,272. 31 May 1977. Filed date 13 Jun 1975. 4p.

A solar collector of the type used to convert the sun's light rays into heat energy is provided. The solar collector includes a steel plate to absorb the sun's rays. A flat coil of tubular steel is attached to the steel plate by means of the hydrogen brazing process. The surfaces of the steel plate and the tubular coil are preferably coated with a thin layer of copper to form a selective surface to promote the efficient collection of energy. 5 claims, 5 figures.

9979 Solar energy apparatus. Coleman, R.F. US Patent 4,026,267. 31 May 1977. Filed date 11 Dec 1975. 8p.

A solar energy apparatus for gathering and transmitting solar radiation to an energy storage area. Wide-angle lens apparatus is used to focus solar radiation on an end of an optical fiber bundle. The other end of the optical fiber bundle is placed in the energy storage area and has a radiating device attached thereto to more efficiently remove the solar energy from the optical fiber bundles. A heat sink is advantageously utilized as a storage means for the solar energy thus gathered and transmitted. 5 claims, 2 figures.

9980 Solar heating apparatus. Fattor, A. US Patent 4,015,585. 5 Apr 1977. Filed date 21 Aug 1975. 8p.

A solar radiation reflector, including a parabolic-trough reflecting surface, transmits solar radiation in a general line reflection on an upright heat absorber during the winter and early spring months of low to moderate sun angles. A juxtaposed overhanging heat absorber is above the upright absorber during summer high-sun angle periods for producing heated transfer medium from each absorber for use in domestic water supply and refrigeration. The reflector may tilt on azimuth to zenith lines for seasonal tilting actions and/or swing East to West to compensate for daily relative sun movement. 8 claims, 12 figures.

9981 Solar heat collector. Liu, B.Y.H.; Jordan, R.C.; Willeke, K. (to Regents of the Univ. of Minnesota). US Patent 4,015,582. 5 Apr 1977. Filed date 31 May 1974. 8p.

A highly efficient solar heat collector is characterized by a layer of light transmitting insulating (i.e., convection and infra-red radiation suppressing) material disposed between the outer surface of the collector and the heat absorptive layer thereof. Glass fibers are a particularly effective lightweight insulating material which may be used. Through use of flexible polymeric films, lightweight, low-cost

solar heat collectors may be fabricated for conversion of existing structures to partial or complete solar heating. Either gaseous or liquid heat transfer fluids may be used. A novel gas-liquid heat exchange system is disclosed. 14 claims, 8 figures.

9982 **Solar fluid heater.** Gallagher, R.G. (to Energy Systems, Inc.). US Patent 4,011,856. 15 Mar 1977. Filed date 28 Mar 1975. 6p.

A solar heater is described that heats a fluid passing through a plurality of side by side positioned solar panels. The solar panels are formed of heat conducting material with an upper solar energy exposed surface covered with a radiant heat absorbing material having high heat absorbing characteristics. A conduit formed of heat conducting material is held in place by an open circular channel of a diameter less than the conduit and positioned below the longitudinal center line of the solar panel. The solar panel portions on each side of the center line slope downward away from the center. The respective ends of the conduits are connected to a separate common header. One header delivers ambient fluid to the conduits and the other removes heated fluid. An insulated housing for containing the solar panel comprises a bottom, side panels, panel supports supported by the bottom panel, insulating material positioned between the bottom panel and the lower surface of the solar panels and at least one transparent panel spaced above the solar panels and sealed to the atmosphere. The solar panels are secured in a fixed side by side physical contacting relationship. The circular channel firmly secures the conduit therein at ambient temperature. When the heater is exposed to solar energy, the heat expands the solar panels and conduit thereby providing an increased pressure between the adjacent panels as well as between the channel and the conduit. Apertures are provided at selected positions along the solar panels near the longitudinal center. Fasteners partially passing through the panel apertures and secured to the panel supports may be provided to increase the physical pressures between the solar panels and the channel and conduit at ambient temperature. 19 claims, 5 figures.

9983 **Radiant energy collector.** Winston, R. (to Energy Research and Development Administration). US Patent 4,002,499. 11 Jan 1977. Filed date 26 Jul 1974. 8p.

An electromagnetic energy collection device is provided which does not require a solar tracking capability. It includes an energy receiver positioned between two side walls which reflect substantially all incident energy received over a predetermined included angle directly onto the energy receiver. 17 claims, 10 figures.

9984 **Solar-thermal energy systems.** Sparrow, E.M.; Sparrow, R.B. (Univ. of Minnesota, Minneapolis). pp 149-182 of In Alternative energy sources. Hartnett, J.P. (ed.). New York; Academic Press (1976).

The discussion is primarily concerned with heat transfer processes in solar thermal systems with emphasis on flat-plate collectors. Topics discussed are: insolation, thermal analysis of flat-plate collectors, flat-plate collector performance results, thermal storage, and space conditioning systems. (MHR)

HEAT STORAGE

REFER ALSO TO CITATION(S) 9943, 9944, 9959, 10620

9985 (COO—2923-3) **Design method for heat loss calculation for in-ground heat storage tanks.** Hooper, F.C.; Attwater, C.R. (Toronto Univ., Ontario (Canada). Dept. of Mechanical Engineering). 1977. Contract EY-76-C-02-2939. 6p. (CONF-771120—4). Dep. NTIS, PC A02/MF A01.

From Winter annual meeting of the American Society of Mechanical Engineers; Atlanta, Georgia, USA (27 Nov 1977).

A relatively simple method for calculating the temperature and heat losses for large, partially buried heat storage tanks over a seasonal heat storage cycle is presented. A lumped parameter approach is used based on three indices evaluated for particular configurations from much more detailed computations. The method appears to offer good accuracy and design convenience in predicting the transient responses of large storages associated with annual heat storage solar heating systems.

9986 (SRO—893-6) **Development of a practical photochemical energy storage system. Quarterly report.** Hautala, R.R.; Kutal, C.R. (Georgia Univ., Athens (USA). Dept. of Chemistry). 15 Sep 1977. Contract EY-76-S-09-0893. 40p. Dep. NTIS, PC A03/MF A01.

It was previously found that the triphenylcyclopropenyl-nickel compound $[(C_6H_5)_3C_3Ni(CO)Br]_2$ (I, X = Br) was an active catalyst for the conversion of quadricyclene to norbornadiene. This result was of considerable interest in connection with the development of the solar energy storage system since it indicated a new type of complex of a relatively abundant metal with potentially useful catalytic properties. For this reason, during this quarter a variety of triphenylcyclopropenyl-nickel derivatives were synthesized in order to determine their structure-activity relationships with respect to catalysis of the conversion of quadricyclene to norbornadiene. Also, a new approach to the development of a polymer-bound catalyst for the conversion of quadricyclene to norbornadiene based on an ion-exchange resin was also explored. Procedures and results are reported. (WHK)

9987 (SRO—893-7) **Development of a practical photochemical energy storage system. Quarterly report.** Hautala, R.R.; Kutal, C.R. (Georgia Univ., Athens (USA). Dept. of Chemistry). 15 Dec 1976. Contract EY-76-S-09-0893. 10p. Dep. NTIS, PC A02/MF A01.

The investigation of triphenylcyclopropenyl nickel derivatives as catalysts for the conversion of quadricyclene to norbornadiene for the thermochemical storage of solar heat was continued. It was attempted to characterize the active catalysts obtained from $[(C_6H_5)_3\ C_3Ni(CO)Cl]_2$ and Grignara reagents, and results are presented. Also, a prototype solar collector which combines the elements of a standard solar collector which heats a "thermal" fluid such as water and the photochemical storage fluid is briefly described. (WHK)

9988 (SRO—893-8) **Development of a practical photochemical energy storage system. Quarterly report.** Hautala, R.R.; Kutal, C.R. (Georgia Univ., Athens (USA). Dept. of Chemistry). 15 Mar 1977. Contract EY-76-S-09-0893. 15p. Dep. NTIS, PC A02/MF A01.

Research on polymer organic sensitizers and polymer inorganic sensitizers for the conversion of norbornadiene to quadricyclene for thermochemical storage of solar heat is described. Also, research on the catalysis of the conversion of quadricyclane to norbornadiene is described. Polymer-anchored cobalt(II) porphyrin catalysts, polymer-anchored palladium(II) phosphine catalysts, and triphenylcyclopropenyl nickel complexes as catalysts were studied, and results are discussed. (WHK)

9989 (SRO—893-9) **Development of a practical photochemical energy storage system. Annual report, June 15, 1976—June 14, 1977.** Hautala, R.R.; Kutal, C.R. (Georgia Univ., Athens (USA). Dept. of Chemistry). 15 Mar 1977. Contract EY-76-S-09-0893. 16p. Dep. NTIS, PC A02/MF A01.

Significant progress toward the development of a solar energy storage system based on the norbornadiene-quadricyclene interconversion has been achieved during the past year. New sensitizers and catalysts have been discovered and conditions found where single cycles of the photosensitization step and the catalytic reversion step appear to be quantitative. Both sensitizers and catalysts have been successfully incorporated onto insoluble polymeric supports. The long term stability of these components is currently being tested using a recently constructed prototype device designed for multiple recycling experiments. Investigations are also underway on design modifications which will allow incorporation of the norbornadiene-quadricyclene system into currently available state-of-the-art solar collectors.

9990 (SRO—893-10) **Development of a practical photochemical energy storage system. Quarterly report.** Hautala, R.R.; Kutal, C.R. (Georgia Univ., Athens (USA). Dept. of Chemistry). 15 Jun 1977. Contract EY-76-S-09-0893. 22p. Dep. NTIS, PC A02/MF A01.

Research on polymeric organic sensitizers and polymeric inorganic sensitizers for the conversion of norbornadine to quadricyclene and catalysts for the conversion of quadricyclene to norbornadine is described. The interconversion of norbornadine and quadricyclene is studied for its possible use for thermochemical solar energy storage. (WHK)

GEOTHERMAL ENERGY

9991 (LBL—6826) **ERDA—DGE/LBL geothermal reservoir engineering management program.** Howard, J.H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1977. Contract W-7405-ENG-48. 8p. (CONF-770747—1). Dep. NTIS, PC A02/MF A01.

From EPRI geothermal program progress report and Geothermal Milestones; Kah-nee-ta, Oregon, USA (25 Jul 1977).

The management program is outlined and the objectives are discussed. The development procedure and implementation of the plan are described. (MHR)

RESOURCE STATUS AND ASSESSMENT

REFER ALSO TO CITATION(S) 10574, 10609

NON-USA

9992 (CONF-760160—1) **Feasibility of using geothermal energy in the Federal Republic of Germany.** Haenel, R. (Niedersaechsisches

Landesamt fuer Bodenforschung, Hannover (Germany, F.R.)). 25 Jan 1976. 29p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

From Meeting of the Institute of Geophysics; Hamburg, F.R. Germany (22 Jan 1976).

The area within the borders of the Federal Republic of Germany was subdivided on a 25 km² grid system. For each section the average temperature at depths of 500, 1000, and 2000 m was plotted. The temperature data was extracted from the archives of the State Bureau of Soil Science of Lower Saxony, which maintains data from oil wells. The plotted temperatures were averaged from a total of 14,000 readings. After the plotting of isotherms, certain thermal anomalies were apparent both in Landau (Rheingraben) and in the area between Urach and Lake Constance. The temperatures at 1000 m depth were 100°C at Landau and 70°C at Urach. In each case the anomaly had a diameter of about 10 to 50 km. The hottest water was found at Rheingraben, with a temperature of 170°C and a hydrostatic pressure of 150 atm at 2500 m depth. This is considered to be too low for efficient power generation using steam.

9993 (CONF-7605168—2) **Present state and future of geothermal resource development.** Mori, T. (Japan Electric Association, Tokyo). 1976. 2p. (In Japanese). TIC.

From 55. annual meeting of Japan Electric Association; Tokyo, Japan (May 1976).

Geothermal energy is a valuable domestic resource of Japan. It is necessary to take steps to expand the utilization of this energy source while, at the same time, ensuring strict environmental protection. The Ministry of Trade and Industry has promulgated policies with regard to geothermal energy since 1973. Geothermal resources in Japan are distributed over seven volcanic chains. Electrical power generation from geothermal sources is expected to reach 2.1 GW by 1985. Investigations are underway of geothermal resources and their distribution, use of hot water for power generation and new geothermal technology.

9994 (NP—22486) **Geothermal energy.** (Bureau de Recherches Geologiques et Minieres (BRGM), 45 - Orleans (France)). Nov 1975. 5p. (In several languages). .

Geothermal fields that have been exploited to date have generally been discovered on the basis of overt surface phenomena such as geysers, furmaroles and hot springs. Many fields exist without demonstrating these phenomena and can be discovered using geophysical and geochemical exploration techniques. Employing these techniques the French Bureau of Geological and Mining Research was able to develop a steam field in the French Territory of Afars and Issas (TFAI). The Asal Lake region was chosen due to geophysical evidence and its proximity to an electrical consumption market. The area is characterized by a very high geothermal gradient (20°C/100 m). Two exploration wells were drilled and a hot water reservoir with a temperature of 259°C was encountered at 1150 m depth. The first well produced 130 t/h of a fluid consisting of about 20 percent steam at 6 bars pressure. Deductive prospecting led to the discovery of a deep reservoir some 10 km from the exploration site. A general description of the Bureau's overall functions is also provided.

9995 (NP—22645) **Heat of the Earth as a source of energy.** (Niedersaechsisches Landesamt fuer Bodenforschung, Hannover (Germany, F.R.); Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hannover (Germany, F.R.)). 1976. 6p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

A geothermal pilot plant with a capacity of 24 Tcal/yr is planned for the Rhine Valley, W. Germany. The installation will be of the hot-dry-rock type. The deep strata will be artificially fractured and cold water will be pumped into the formation to be heated. The steam generated will be used for electricity generation and space heating. This type of power plant is expected to have a practical life-span of approximately 25 years.

9996 **Geothermal energy in Denmark.** *Tek. Ukebl.;* **124**: No. 55, 8-9(Aug 1977). (In Danish).

Three areas with promising geothermal energy resources were located in North Jutland, Denmark. Porous sandstone strata up to 50 m thick were determined to lie at depths between 2 and 3 km; they bear thermal waters with temperatures ranging from 60 to 100°C. Deeper strata contain water having higher temperatures. It is estimated that reducing the water temperature from 80°C to 40°C would yield 400 Tcal/km². Hot water pumped to the surface could easily be applied in district heating schemes. After circulation and heat exchange at the surface, the water would be reinjected at a point several kilometers distant from the extraction wells. The system would be equipped with an oil-fired auxiliary for use during peak winter loads.

9997 **Heat from the earth - an important energy source.** *Erdoel Kohle, Erdgas, Petrochem. Brennst.-Chem.;* **30**: No. 2, 59-60(Feb 1977). (In German).

Geothermal energy is an essentially renewable energy source. By reducing the underground temperature in the Federal Republic of Germany to a uniform 100°C to a depth of 5 km, the quantity of energy derived would be equivalent to 3000 times the amount consumed per year. Natural sources of hot water exist at the border of the Rhinegraben in the Black Forest, to the north of the Eifel area, at Aachen, and at Baden-Baden. Extensive data on Germany's geothermal resources has been obtained from drilling programs, particularly in the area between the Alps and the Danube River. The highest subterranean temperatures have been recorded in the upper Rhinegraben and at Urach. The installation of a geothermal power plant in the Rhinegraben area (capacity 24 Tcal/y) has been proposed.

9998 **Geothermal resources.** Iga, H. (Japan Geothermal Energy Association). *Denki Hyoron;* **62**: No. 3, 20-28(1977). (In Japanese).

A review is presented of geothermal energy in terms of energy analysis, economics, estimated reserves, and new methods of exploitation. The geothermal generating capacity of those countries active in development is summarized. As of June 1976, the total generating capacity of all countries was 1.3 GW, 70 MW of which was represented by Japan. Another 100 MW is planned for Japan in the near future. The largest single generator in use was the 110 MW No. 11 generator at the Geysers geothermal field. The average size of generators in use was about 50 MW. The small size of these turbines makes the initial cost of geothermal plants somewhat higher than that of fossil fuel fired power plants. However, the subsequent operating cost of geothermal plants is lower, resulting in more favorable cost per kWh. The 1976 price of geothermal electricity in Japan was 7 yen/kWh as compared to 9 yen/kWh for conventional plants. The Japanese Government predicts that 2.1 GW of geothermal generating capacity is possible for Japan by 1985 and that new exploitation methods may make a total of 48 GW available.

9999 **Recommendations for geothermal development.** Sakakura, S. (MITI Cast and Wrought Iron Products Div., Japan). *Chinetsu Gijutsu;* No. 3, 1-7(Jul 1976). (In Japanese).

Japan has 65 active volcanoes and more than 200 geothermal fields. At the time of writing, four electrical power generation plants were in operation and three were under construction with a total capacity of 220 MW. The Ministry of International Trade and Industry forecasts the possibility of 48 GW by the year 2000 while the Kyushu-Yamaguchi Economic Association reports that 10 GW will be possible in Kyushu alone. The 1973-1974 geothermal investigation by the Sunshine Project concluded that in the 20 areas surveyed about 20 GW will be possible in view of the amount of radiant heat. The cost per kWh generated is extremely low, even in comparison with nuclear plants. These facts are important in view of the conventional fuel shortage.

10000 **Can geothermal energy be used in West Germany** . Delisle, G. (Bundesanstalt fur Geowissenschaften und Rohstoffe, Hannover, DE); Jung, R. *Umschau;* **76**: No. 20, 651-653(1976). (In German).

The hot-dry-rock project of LASL is described. The hot-dry-rock concept is viewed as the best approach to exploitation of geothermal energy in Germany. At Landau (Pfalz), temperatures reach 100°C at a depth of 1 km. If 2.5 km² of rock were cooled to 100°C to a depth of 7 km, the energy recovered would be sufficient to operate a 1 GW power plant. Other areas of interest are the Schwabian Alps where temperatures reach 70°C at a depth of 1 km, and the S. Bavarian molasse area where water at 170°C is recoverable.

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

10001 **Transport phenomena in hydrothermal systems: the nature of porosity.** Norton, D. (Univ. Arizona, Dept. Geosciences, US); Knapp, R. *Am. J. Sci.;* **277**: 913-936(Oct 1977).

The porosity (P) of rock is described by: P-total = P-flow + P-diffusion + P-residual. Experimental results show that P-total of fractured rock in hydrothermal systems ranges from 0.2 to 0.01, and P-diffusion ranges from 0.001 to 0.00001. Data from the literature and from field studies of fractures indicate that P-flow is 0.001-0.00001. Consequently, the greater part of P-total in plutonic environments results from residual pores which are not interconnected to P-flow or P-diffusion. Permeability is a function of the abundance and geometry of continuous flow paths. Observations suggest that a planar fracture is a good first order approximation for fractures in plutonic environments. Analysis of aperture, abundance, and continuity suggests that permeabilities on the order of 1.0 nm² may be characteristic of large portions of the crust. The model proposed permits definition of the interface between circulating hydrothermal fluids and reactant minerals in a manner consistent with the physical phenomena and partial differential equations which describe the processes of advection-diffusion-reaction.

10002 Transport phenomena in hydrothermal systems: cooling plutons. Norton, D. (Univ. of Arizona (Tucson), Dept. of Geosciences); Knight, J. *Am. J. Sci.;* 277: 937-981(Oct 1977).

The nature of heat and mass transport in plutonic environments has been described by partial differential equations and simulated by numerical approximation. A series of heuristic models based on these equations describes the general features of fluid circulation near an igneous intrusive body within the upper 10 km of the crust. Analysis indicates that fluid circulation is an inevitable consequence of magma emplacement. The magnitude of this circulation generates convective heat fluxes which predominate over conductive fluxes when host rock permeabilities exceed 1.0 nm^2. However, cooling rates for the pluton are not significantly shortened unless the pluton permeability is also greater than 1.0 nm^2. The geometries of circulation and isotherms are directly affected by variations in pluton size, depth, and permeability as well as permeability distribution in the host rock. The effect of fluid properties on heat and mass transport is striking. The style of circulation is controlled by coincident maxima of the isobaric thermal coefficient of expansion and heat capacity with the viscosity minima in the supercritical region of the H_2O system. Waters in intrusive systems are predicted to move several km in a few hundred thousand years. Temperature and pressure changes along the flowpaths produce changes in solvent properties. The fluid-rock interactions should generate diagnostic mineral assemblages and isotopic changes. Average fluid:rock mass ratios of 0.4 are realized over the permeable portions of the systems. The extent of circulation, and magnitude of convective heat flux over broad crustal regions and along plate boundaries may be much greater than suspected.

USA

REFER ALSO TO CITATION(S) 10026, 10043

10003 (COO—2720-1) **Preliminary petrographic and geophysical interpretations of the exploratory geothermal drill hole and core, Redstone, New Hampshire.** Hoag, R.B. Jr.; Stewart, G.W. (New Hampshire Univ., Durham (USA). Dept. of Earth Sciences). 30 Jun 1977. Contract EY-76-S-02-2720. 128p. Dep. NTIS, PC A07/MF A01.

A 3000 foot diamond drill hole was drilled in the Conway Granite in Redstone, New Hampshire. A comprehensive detailed petrographic and physical study of this core was made. The purpose of this study is to supply a sound data base for future geothermal and uranium-thorium studies of the drill core. An estimate of the heat flow potential of the Redstone drill hole gives a heat flow of 1.9 HFU. If only the red phase of the Conway Granite had been intersected the heat flow may have been as much as 2.7 HFU, reaching a temperature of 260°C at 6 km. The drill hole intersected four lithologies; the green and red phase of the Conway Granite, the Albany quartz syenite and a medium-grained, hastingsite-biotite granite. The red phase has the highest and most irregular radioactivity. The irregularity is mainly due to minor variations in lithology. The drill core intersected several alteration zones up to a thickness of 150 feet. These alteration zones represent passage of low to medium temperature fluids which might have been mineralized. The Conway Granite has the physical and chemical characteristics necessary for the formation of vein type uranium deposits. The presence of unexplained radiometric anomalies lends support to the existence of such deposits.

10004 (LA—6930-MS) **Petrography and geochemistry of precambrian rocks from GT-2 and EE-1.** Laughlin, A.W.; Eddy, A. (Los Alamos Scientific Lab., N.Mex. (USA)). Aug 1977. Contract W-7405-ENG-36. 50p. Dep. NTIS, PC A03/MF A01.

During the drilling of GT-2 and EE-1, 27 cores totaling about 35 m were collected from the Precambrian section. Samples of each different lithology in each core were taken for petrographic and whole-rock major- and trace-element analyses. Whole-rock analyses are now completed on 37 samples. From these data four major Precambrian units were identified at the Fenton Hill site. Geophysical logs and cuttings were used to extrapolate between cores. The most abundant rock type is an extremely variable gneissic unit comprising about 75% of the rock penetrated. This rock is strongly foliated and may range compositionally from syenogranitic to tonalitic over a few centimeters. The bulk of the unit falls within the monzogranite field. Interlayered with the gneiss is a ferrohastingsite-biotite schist which compositionally resembles a basaltic andesite. A fault contact between the schist and gneiss was observed in one core. Intrusive into this metamorphic complex are two igneous rocks. A leucocratic monzogranite occurs as at least two 15-m-thick dikes, and a biotite-granodiorite body was intercepted by 338 m of drill hole. Both rocks are unfoliated and equigranular. The biotite granodiorite is very homogeneous and is characterized by high modal contents of biotite and sphene and by high K_2O, TiO_2, and P_2O_5 contents. Although all of the cores examined show fractures, most of these are tightly sealed or healed. Calcite is the most abundant fracture filling mineral, but epidote, quartz, chlorite, clays or sulfides have also been observed. The degree of alteration of the essential minerals normally increases as these fractures are approached. The homogeneity of the biotite granodiorite at the bottom of GT-2 and the high degree of fracture filling ensure an ideal setting for the Hot Dry Rock Experiment.

10005 (NP—22410) **Regional tertiary cross sections: Texas Gulf Coast.** Debout, D.G.; Luttrell, P.E.; Seo, J.H. (Texas Univ., Austin (USA). Bureau of Economic Geology). 1976. vp. of Texas, Austin.

Regional studies of the Frio Formation along the Texas Gulf Coast were conducted to evaluate potential geothermal energy from deep, geopressured sandstone reservoirs. Published regional cross sections, unpublished cross sections provided by several major oil companies, and extensive micropaleontological and electrical-log files at the Bureau of Economic Geology served as basic data. These sections are meant to show gross regional distribution of sand and shale facies both laterally and vertically throughout the entire Tertiary section along the Texas Gulf Coast.

10006 (NP—22439) **Geothermal resources: Frio Formation, Upper Texas Gulf Coast. Geological circular 76-3.** Bebout, D.G.; Loucks, R.G.; Bosch, S.C.; Dorfman, M.H. (Texas Univ., Austin (USA). Bureau of Economic Geology). 1976. 48p. of Texas, Austin.

Major sand trends were identified in the Frio Formation, Upper Texas Gulf Coast as part of the evaluation of its potential for producing geothermal energy. Electrical logs from 465 wells spaced 5 to 10 miles apart were used in the study. Maps illustrating total net sand and total sand percentage of the Frio Formation are included. It was found that subsurface fluid temperatures of greater than 250°F occur in the Frio sand bodies up to 100 ft thick downdip of the high-sand trends. LA broad band in Brazoria and Galveston Counties was delineated as having geothermal potential. (JGB)

NON-USA

10007 (NP—22304) **Hydrochemical features of the northern Latium (central Italy) with particular reference to the Stigliano thermal springs.** Baldi, P.; Ferrara, G.C. (Ente Nazionale per l'Energia Elettrica, Pisa (Italy). Centro di Ricerca Geotermica). 1976. 14p. Dep. NTIS (US Sales Only), PC A02/MF A01.

A report is presented on investigations of thermo-mineral springs in part of northern Latium. Based on such physicochemical parameters as temperature, salinity and ionic content, two main water systems were determined to exist. One occurs in the volcanic surface rocks (200 to 300 m depth) and the other in a confined reservoir at a depth of 600 to 1,200 m. The study showed that the deep reservoir is a hot water system with temperatures below 100°C. The waters of the Stigliano springs may be traced to their source even though they exhibit different chemistry. The differences seem to be due to processes of differential cooling and of fractional evaporation.

10008 (NP—22305) **Hydrogeochemistry of the region between Monte Amiata and Rome.** Baldi, P.; Ferrara, G.C.; Masselli, L.; Pieretti, G. (Ente Nazionale per l'Energia Elettrica, Pisa (Italy). Centro di Ricerca Geotermica). 1976. 47p. Dep. NTIS (US Sales Only), PC A03/MF A01.

A study was performed on the hydrogeology and geochemistry of mineral manifestations in the area limited by Mt. Amiata to the north, the Tiber river to the east, Rome to the south and the Tyrrhenian Sea to the west. These manifestations (about 200) are distributed over about 5,000 km^2. As a result, it was possible to locate the areas of possible supply of meteoric waters and to determine the circulation patterns to a depth of about 1,000 to 1,200 m. The most promising areas for discovery of hyperthermal waters were determined. Some ions or compounds, notably boron, silica, chlorine, magnesium and the sulfates, proved particularly significant in making determinations. In general, thermomineral manifestations represent the surface trace of two essential types of circulation. One occurs almost exclusively within the volcanic cover (200 to 300 m) and the other, deeper, predominantly involving the calcareous Mesozoic substrate at various levels (at least 600 to 700 m). Due to particular lithologic and tectonic situations, marked mixing occurs between the two circulation types on a local level. From such mixing a series of individual effluents featured by chemical and thermal characteristics midway between the extremes originate.

10009 Studies of the hot water systems of geothermal springs - Part I (outline and purpose). Sumi, K. *Chinetsu Gijutsu;* No. 5, 22-38(Jan 1977). (In Japanese).

Research on the hot water systems of geothermal fields was begun in 1973 and is being continued by The Institute of Industrial Technology under the auspices of the Sunshine Project. Four areas were chosen as models for the studies, Onikubi in Miyagi prefecture, Konoe in Kumamoto, Hachimandaira in Iwate and Yukatsu in Akita. Geology, geophysics, geochemistry and hydrology were studied in these areas. Wells were drilled to 1000 m depth and fluid extracted. By comparing the products of the different areas the nature of the hot water systems was clarified. Interim reports on water resources,

weather, precipitation, water isotope chemistry, distribution of metamorphic rocks, fault systems and well measurements are presented. Hydrological maps are provided, as are flow charts and analytical tabulations.

10010 Red Sea heat flow. Girdler, R.W. (Univ. Newcastle on Tyne, School of Physics, GB); Evans, T.R. *Geophys. J. R. Astron. Soc.;* **51**: No. 1, 245-251(1977).

The number of heat flow observations in the Red Sea has increased five-fold since 1970, due to its plate-tectonic significance as an active spreading center. A new heat flow map of the area is presented, along with a tabulation of data. These data confirm that the entirety of the Red Sea is an area of high heat flow. Observations within 5 km of the axial trough have a mean value of 467 mW/m², and from 50-170 km from the axis they have a mean of 111 mW/m². The observations are difficult to assess in detail, due to the complex sedimentary and tectonic setting. Observations near the axial spreading zone are highly variable. The variation probably arises from the effects of evaporite flow and hydrothermal circulation. The heat flow is consistently high along the coastline (112 mW/m²), and temperatures of 100°C are reached at depths of less than 2.0 km. This indicates that a source of geothermal energy for the ports of the Red Sea may be readily available.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

REFER ALSO TO CITATION(S) 9994

10011 Explanation of geothermal studies requisitioned by the Sunshine Project. Adachi, Y. *Chinetsu Gijutsu;* No. 2, 29-44(Apr 1976). (In Japanese).

The development of exploration techniques for large scale geothermal areas is reported. These developmental studies are being sponsored by the Sunshine Project. The Hachimandaira district was selected as a model for the analysis of thermal structure. The items undergoing research include thermal flow measurement and analaysis equipment, geothermal thermometers, thermal structure analysis through microearthquakes, air drilling techniques, topographic and geologic mapping and geophysical surveying (including gravity and free air magnetism). This research is expected to be completed and the results published in 1978.

GEOPHYSICAL TECHNIQUES AND SURVEYS

10012 (LBL—6332) Analysis of the bipole—dipole resistivity method for geothermal exploration. Dey, A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1977. Contract W-7405-ENG-48. 63p. Dep. NTIS, PC A04/MF A01.

Bipole-dipole (B-D) resistivity mapping has been widely used as a reconnaissance method in geothermal exploration. In this technique, apparent resistivities are plotted at roving dipole receiver locations and the current source (bipole) is left fixed. Interpretation to date has been in terms of simple layered, dike, vertical contact, or sphere models. In the case of more complicated two-dimensional models the interpretation is much more ambiguous and the detection of buried conductors depends very much on the choice of transmitter location. Since apparent resistivities taken on a line collinear with the bipole are roughly equivalent to the apparent resistivities for one sounding in a dipole-dipole (D-D) pseudo-section, the two methods have been compared for several two-dimensional models. A buried quarter space and a buried horizontal block of rectangular cross section, with or without an overburden layer, have been used in the comparison. Unless the target is very shallow or close to the bipole or dipole, the resolution of the horizontal position or depth extent for the B-D method is very poor. A further experiment of calculating a residual map by subtracting the half-space or layered half-space response from the response of the buried models was also unsuccessful in improving the interpretability of the B-D method. Finally, a model representative of a typical Basin-and-Range valley with and without a hypothesized geothermal reservoir shows that in more complex models the B-D map would not, in a practical survey, reveal the reservoir. From these model studies it is clear that, except for some simple geologic situations, the B-D method is not effective for subsurface mapping. Selected D-D lines would be far more useful and more cost effective.

10013 (USGS-OFR—77-66C) Telluric profile location map and telluric data for the Baltazor Known Geothermal Resource Area, Nevada. Hoover, D.B.; Peterson, D.L.; Farkash, V. (Geological Survey, Reston, Va. (USA)). 1977. 3p. TIC.

Telluric profile data and a telluric traverse location map are presented for the Baltazor Known Geothermal Resource Area (KGRA), Nevada. (JGB)

GEOCHEMICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 10004, 10007

10014 Geochemical consideration on the quality of spring waters in Dogo Spring Group, Shikoku, Japan. Maki, T. (Ehime Univ., Matsuyama, Japan); Takechi, T.; Yamatake, S.; Eguchi, S.; Shimamoto, T. *Onsen Kogakkaishi;* **11**: No. 2-3, 55-67(1976). (In Japanese).

Dogo spa group is located in the central part of Ehime Prefecture and consists of three hot spring areas, Dogo, Okudogo and Higashidogo. The region mainly consists of granitic rocks and mesozoic sandstones, and there is no running recent volcanic belt. The quality of the hot spring waters in these areas was investigated, and the results were analyzed by statistical methods. The water quality of the hot springs was that of a simple alkaline spring containing considerable amount of fluorine. There was a positive correlation between the water temperature and the amount of dissolved matter. There was more Na present than any other positive ion, occupying more than 90% in milligram equivalent except in a few cases. The volume of Na had a strong positive correlation with that of Li. There was a strong correlation between the negative ions and the amount of dissolved matter: Cl and Cl + F had positive correlation, and CO_3 and SO_4 had negative correlation, but fluorine alone had no particular correlation. The value of (Cl + F)/Na approached one as the amount of dissolved matter increased. It is concluded that the chemical constituents of the ascending original hot spring waters consist mostly of NaCl with a small amount of NaF. Concentration of the dissolved matter is about 450 ppM in Dogo and Okudogo areas and about 1000 ppM in Higashidogo area.

10015 Distribution of radon concentration in hot-spring waters from the Kakuto Basin, southern Kyushu. Sato, K.; Sato, J. (Tokyo Univ.). *Onsen Kogakkaishi;* **11**: No. 2-3, 68-72(1976). (In Japanese).

The radon concentration measured for hot-spring waters from the Kakuto Basin, one of the collapse calderas in southern Kyushu, varies considerably. The springs so far studied can be classified into two distinct groups of the low ($\sim 10^{-12}$ Ci/l) and the high ($\sim 10^{-10}$ Ci/l) concentration, though the radon concentrations of the latter group appear to vary from time to time. Available data for a few boring-core samples and an inspection of spatial distribution of the hot springs in the basin indicate that the sources of the low concentration group are probably located within solid materials constituting the immediate basement or margin of the caldera, whereas the sources of the high concentration group are all distributed within unconsolidated, post-caldera sediments. No significant difference in the radium content is observed between the post-caldera sediments and the volcanic rocks from the margin. It is concluded that the radon concentration of the hot springs in the basin reflects to some extent the degree of consolidation of the caldera-forming materials with which such waters are in contact.

EXPLORATORY DRILLING AND WELL LOGGING

10016 (NP—22321) Recent developments of geothermal exploration in the Travale-Radicondoli area. Burgassi, P.; Cataldi, R.; Rossi, A.; Squarci, P.; Stefani, G.C.; Taffi, L. (Ente Nazionale per l'Energia Elettrica, Florence (Italy)). 1976. 24p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Based on a reinterpretation of previously acquired data relative to the Travale field, a program of geothermal exploitation was undertaken in 1969. A number of geophysical surveys were made and deep wells were drilled. In 1971 Travale 22 was drilled 2 km NE of the previously exploited area and produced 314 t/h of steam. Since 1973 this well has supplied a 15 MW plant (specific consumption 12 kg/kWh). Subsequently, the R1, R2 and R4 wells were drilled within an area 1 km from Travale 22. Below the cap rock R1 and R2 encountered temperatures of 250 to 270°C in very low permeability rocks. R4 has produced 108 t/h of gas/steam. A step-fault structure with a total throw of about 700 m separates Travale 22 and R4 reservoirs, thereby explaining the considerable difference in composition and performance of the wells.

LEGAL AND INSTITUTIONAL ASPECTS

10017 (NP—22494) Geothermal energy operations and objectives of the B.R.G.M. (76 SGN 519 GTH). (Bureau de Recherches Geologiques et Minieres (BRGM), 45 - Orleans (France)). Oct 1976. 16p. (In French). Dep. NTIS (US Sales Only), PC A02/MF A01.

The contributions of the Bureau de Recherches Geologiques et Minieres (BRGM) to investigation and exploitation of geothermal energy are reviewed. The BRGM intervenes at the following levels: technology transfer; technical assistance; public service; and consultations on questions of organization, documentation, prospective operation and administration. At these levels the BRGM works cooperatively or dispatches advisers. Studies of geothermal resources and printed works are made available. A flow chart demon-

strates the relationship between levels of service and levels of demand. Sections of the BRGM are devoted to the study of both high and low enthalpy geothermal resources.

ECONOMIC AND FINANCIAL ASPECTS

10018 Inspection trip to Hachimandaira geothermal field-first impression of geothermal energy. Yamamoto, A. *Chinetsu Gijutsu;* No. 5, 60-66(Jan 1977). (In Japanese).

The Hachimandaira geothermal field and its power generating facilities are described. A comparison is made between the cost of electricity production in geothermal facilities and the equivalent derived from petroleum. Steam production at Hachimandaira is 35 t/h. As 10 MW/h are produced with a flow of 100 t/h, the Hachimandaira plant is capable of 3.5 MW/h. It would require 45.4 barrels of oil to produce the equivalent (given that 1 barrel=159 liters and the thermal energy of oil=10 Mcal/liter and 1 KW/h=0.86 Mcal). The average amount of oil produced by wells in the free world is about 80 barrels/day. Consequently, geothermal energy is a most promising resource.

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

10019 (EPRI-ER—352) Geothermal environmental studies, Heber Region, Imperial Valley, California. Environmental baseline data acquisition. Final report. (San Diego Gas and Electric Co., Calif. (USA)). Feb 1977. 308p. Dep. NTIS, PC A14/MF A01.

The Electric Power Research Institute (EPRI) has been studying the feasibility of a Low Salinity Hydrothermal Demonstration Plant as part of its Geothermal Energy Program. The Heber area of the Imperial Valley was selected as one of the candidate geothermal reservoirs. Documentation of the environmental conditions presently existing in the Heber area is required for assessment of environmental impacts of future development. An environmental baseline data acquisition program to compile available data on the environment of the Heber area is reported. The program included a review of pertinent existing literature, interviews with academic, governmental and private entities, combined with field investigations and meteorological monitoring to collect primary data. Results of the data acquisition program are compiled in terms of three elements: the physical, the biological and socioeconomic settings.

10020 Investigations of the mechanism of hot water reinjection. Nakamura, H. *Chinetsu Gijutsu;* No. 2, 45-48(Apr 1976). (In Japanese).

After steam is separated from hot water in a geothermal production well the steam is piped to the turbine and the hot water remains to be disposed of in some way. The ratio of steam to water is generally about 1/4-5. A large reinjection well is necessary to dispose of this quantity of water. A study of reinjection mechanisms is being carried out by the Sunshine Project in the Takinoue area. Research is being concentrated on optimization of injection techniques, tracing injection pathways, and determining the effects of reinjection. These investigations will continue into 1977.

10021 Activation analysis of plants within regions of geothermal resource development. Nakahara, H. (Dept. of Chem., Tokyo Metro. Univ., JP); Yanokura, M.; Murakmi, Y. *J. Radioanal. Chem.;* **37**: No. 2, 839-847(1977).

Studies were made of the environmental effects of a geothermal production area within a National Park on Kyushu. Analyses were made of the steam and hot water produced and of elemental uptake by plants in the area, specifically bamboo grass and susuki (pampas grass). Neutron activation was found to be the best analytical technique. Twenty four elements could be identified without chemical separation of the samples. The amounts of the chemical species present in the plants were plotted against the distance from the source wells and distinct correlations were seen for Na, Cl, Rb, Cs, As, and Sb. These species were especially abundant in the hot water produced. It was concluded that plants growing within a radius of 400-500 m from the production wells were affected by aerosol pollutants from the wells.

10022 Trend of geothermal development. Mori, Y. *Chinetsu Gijutsu;* No. 2, 3-11(Apr 1976). (In Japanese).

A bill was submitted to the Japanese Diet which would augment the development of geothermal energy. In addition to defining geothermal resources it included provisions for basic exploration, developmental strategies, reporting procedures, governmental organization and liaison, funding, proposed completion dates and assignation of a major role to the Ministry of Industry and Trade.

GEOTHERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 9995, 10044

10023 Direct thermal-electric conversion for geothermal energy recovery. Levoy, L. US Patent 4,047,093. 6 Sep 1977. Filed date 17 Sep 1975. 38p.

Direct conversion systems for in-situ conversion of geothermal energy into electricity are described in which thermoelectric generators and/or thermionic converters directly convert the earth's thermal energy into electrical energy. The choice of a thermoelectric or thermionic system is dictated by the temperature domain of the particular geothermal formation. The basic unit of the described system includes at least two coaxially-intersecting heat pipes, extending between a high temperature geological strata and a low temperature geological strata. Thermal-electric energy conversion devices are positioned within an annulus between the intersecting heat pipes.

POWER PLANT SYSTEMS AND COMPONENTS

10024 (COO—4051-10) Effect of seasonal variations of ambient temperatures on the performance of low temperature power cycles. Khalifa, H.E. (Brown Univ., Providence, R.I. (USA). Div. of Engineering). 1977. Contract EY-76-S-02-4051. 19p. Dep. NTIS, PC A02/MF A01.

Studies on the performance of the binary fluid system was carried out in two stages. In the first stage the ideal case was analyzed as to the effects of sinusoidal variations of the heat rejection temperature on the ideal work available from a steady flow of a geothermal brine delivered to a power plant under constant wellhead conditions. In the second stage an approximate method for analyzing actual cases was introduced. Results indicate that sink temperature fluctuations have a drastic effect on the output of low-temperature power cycles. The severe fluctuations in the output are likely to have a strong influence on the design and optimization studies of such cycles. The impact of this on the economies of electric power generation from geothermal resources should be carefully assessed before choosing among possible energy-conversion systems. (JGB)

10025 (TREE—1164) Floating power optimization studies for the cooling system of a geothermal power plant. Shaffer, C.J. (EG and G Idaho, Inc., Idaho Falls (USA)). Aug 1977. Contract EY-76-C-07-1570. 94p. Dep. NTIS, PC A05/MF A01.

The floating power concept was studied for a geothermal power plant as a method of increasing the plant efficiency and decreasing the cost of geothermal power. The stored cooling concept was studied as a method of reducing the power fluctuations of the floating power concept. The studies include parametric and optimization studies for a variety of different types of cooling systems including wet and dry cooling towers, direct and indirect cooling systems, forced and natural draft cooling towers, and cooling ponds. The studies use an indirect forced draft wet cooling tower cooling system as a base case design for comparison purposes.

10026 (UCRL—50046-76) LLL Geothermal Energy Program. Status report, January 1976—January 1977. Austin, A.L.; Lundberg, A.W.; Owen, L.B.; Tardiff, G.E. (comps.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 Apr 1977. Contract W-7405-ENG-48. 170p. Dep. NTIS, PC A08/MF A01.

Titles of the five sections are: program description; program plans and results; energy-conversion engineering; brine chemistry and materials; and earth sciences program. The last three sections were abstracted and indexed individually for ERA/EDB. (JGB)

10027 (UCRL—50046-76, pp 15-50) Energy-conversion engineering. 27 Apr 1977.

In LLL Geothermal Energy Program. Status report, January 1976—January 1977.

Research progress on the total flow impulse turbine is reported under the following section headings: rationale for the impulse turbine; description of the impulse turbine; impulse turbine test facility; experimental results; prediction of expander performance; extrapolations to full-admission performance and to an improved design; nozzle design and analysis; droplet-phase characterization; strategy for droplet-size reduction; preliminary cost estimate; and future activities for the total flow impulse-turbine system. Research progress on alternative energy-conversion systems is reported under the following section headings: introduction and description of hybrid concepts; the LLL geothermal reaction turbine; turbine performance; development schedule; reaction-turbine applications, and summary. (JGB)

10028 Energy recovery from geothermal reservoirs. Franz, W.F.; Hess, H.V. (to Texaco Inc.). US Patent 4,043,386. 23 Aug 1977. Filed date 30 May 1975. 6p.

A method is described for recovering energy from a geothermal reservoir in which brine from the reservoir is first employed to

heat an immiscible fluid, such as a hydrocarbon in direct heat exchange, and the heated hydrocarbon is then utilized in direct heat exchange to heat a second fluid, such as boiler feed water, to raise steam as the actual working fluid in the power cycle.

10029 R and D of hot water binary cycle power generation system. Okuhara, T.;Sekiya, E. *Chinetsu Gijutsu;* No. 4, 45-53(Oct 1976). (In Japanese).

A one MW binary thermal loop was designed and built. The working fluid selected was R-114. The facility was built in the Yukawa area of Hokkaido, Japan. The hot water input has a temperature of 140°C and a flow rate of 180 t/h. The temperature of the cooling water is 15°C. The heat exchangers, turbine, and floor plan of the facility are described. The results of analyses of the geothermal and river waters are provided and the results of corrosion and fatigue simulation tests are tabulated.

10030 R and D of a steam binary cycle power generation system. Higuchi, H. *Chinetsu Gijutsu;* No. 4, 54-59(Oct 1976). (In Japanese).

A summary is provided of research and development of a steam based binary cycle power generation system. Major components such as boilers, multi-stage flashing preheaters, air cooled condensors, pumps, turbines, and generators are described. Test equipment for the heat exchange loop and a portable experimental loop were built in order to study the effects of reduced heat transfer, fluid flow blockages and corrosion. These experimental facilities are equipped with automatic measuring and recording devices which monitor scale deposits, heat transfer rate, and corrosion rate as functions of time and temperature. In particular, the solubility of isobutane in turbine oil was studied in order to determine design parameters for oil seals. It was found that in the temperature range of 40-126°C and under pressures of 0.01 to 26.5 atm there is no chemical reaction between isobutane and turbine oil.

10031 Research and development of steam-combined type binary cycle geothermal power generation system. Higuchi, H. (Mitsubishi Heavy Industries, Ltd.). *Chinetsu Gijutsu;* No. 3, 56-61(Jul 1976). (In Japanese).

Being of the opinion that steam-combined type binary power generation would be profitable, Mitsubishi proposed the plan to the Sunshine Project and was able to take part in the development of a 1000 kW system. At the end of a one year research and development period (1975) it was found that power could be generated by vaporizing a low temperature medium, using geothermal hot vapor without generation of pollution and at good efficiency. The low temperature media with potential for application to the system include ammonia, hydrocarbons, freon gas and various organics. Of these the most promising are isobutane and freon. The major problems identified involved the physical size necessary for some equipment and the necessity of preventing deposits on the heat exchanger surfaces.

10032 Research and development of hot water specialty type binary cycle power generation system. Okuhara, I. (Tokyo Shibaura Electric Co., Ltd.);Sekiya, E. *Chinetsu Gijutsu;* No. 3, 49-55(Jul 1976). (In Japanese).

The binary cycle system planned by Toshiba Electric Co. is one in which an evaporator and heat exchanger are installed to heat a working medium to a predetermined temperature by means of hot water from geothermal wells. The heated medium then enters a turbine and proceeds to a condensor where it is pressurized further by a pump and preheated. The Geothermal Technology Development Co. has joined the research team and plans to develop a heat exchanger for the heat transfer from hot water to vaporizing fluid. They are working with a 1 MW thermal loop experimental system with a view to developing a 10-50 MW final generating system. In July 1976 the design of the major component (heat transfer pipe) had been completed.

GEOTHERMAL ENGINEERING

REFER ALSO TO CITATION(S) 10722

10033 Geothermal energy from salt formations. Altschuler, S.J. (to Dow Chemical Co.). US Patent 4,052,857. 11 Oct 1977. Filed date 6 Oct 1976. 8p.

A method is described for obtaining geothermal energy from salt formations in which a well is drilled and cased into a suitable salt formation to a depth where the temperature is such that the salt behaves plastically. A weighted, closed end pipe is inserted into the well with its lower, closed end at about the bottom of the salt formation. Thereafter an insulated open end pipe is inserted, after the weight has been removed from the closed end pipe, within the closed end pipe, thus forming a double pipe heat exchanger. A heat exchange fluid is circulated, usually in a closed loop, through the double pipe heat exchanger, an energy extracting means, such as, for example, a steam generator or an hydraulic turbine, and back through the heat exchanger. 6 claims, 7 figures.

DRILLING TECHNOLOGY AND WELL HARDWARE

REFER ALSO TO CITATION(S) 10046

10034 Development of high temperature strata drilling technology (1974 and 1975) - (1) feasibility study. Saotome, I. *Chinetsu Gijutsu;* No. 5, 48-59(Jan 1977). (In Japanese).

A review is presented of the techniques of drilling in high temperature geological formations. Components of drilling rigs, new types of equipment and methods of reservoir stimulation by rock fracturing are discussed. Both the circulation of drilling mud and the techniques of air drilling at depth are described in detail. Typical problems encountered in high temperature drilling are mentioned and some possible solutions are offered in terms of improved methods and materials. New drilling techniques such as electric heating, thermal stress generation and down-hole drilling are covered. The development of drilling equipment in countries other than Japan is described.

10035 Research and development of cement available under geothermal environment. *Chinetsu Gijutsu;* No. 3, 40-48(Jul 1976). (In Japanese).

Since 1974 Teikoku Oil, Ternite and Nihon Cement have conducted research and development projects on high temperature cements for use in geothermal wells. Attempts have been made to develop cements which can operate in environments ranging from 200-750°C and up to 2.76 x 10^7 N/m². The addition of 40% silica stone powder resulted in an increase in compressive strength, more than 250 kg/cm² at 14 days age and greater than 300 kg/cm² at 30 days. The addition of a lignin retarder increased the compressive strength to 500 kg/cm² at 30 days and 220°C. The results were supported by testing in a well at 1,003 m depth and 220°C temperature.

10036 Research and development of drilling mud workable under geothermal environment. *Chinetsu Gijutsu;* No. 3, 32-39(Jul 1976). (In Japanese).

Tests were made on the behavior of 3% and 5% bentonite suspensions in which five kinds of dispersive deflocculants composed of lignin and humic acid were dissolved at temperatures of 150-180-200°C with a high temperature aging apparatus. Measurements were made on the change of properties of a mud consisting of a 2% bentonite suspension to which 1% asbestos and 3-5-7% dispersive deflocculants were added after being heat treated at 220°C. It was found that the nitro-humic acid/salt-gilsonite complex as a coordinator for high temperature drilling mud can retain a stable fluidity and maintain a good dehydrating effect even at 200°C.

FLUID TRANSMISSION

REFER ALSO TO CITATION(S) 10046

CORROSION, SCALING, AND MATERIALS DEVELOPMENT

REFER ALSO TO CITATION(S) 10026

10037 (UCRL—50046-76, pp 51-126) **Brine chemistry and materials.** 27 Apr 1977.

In LLL Geothermal Energy Program. Status report, January 1976—January 1977.

Research on brine chemistry and materials technology for the total flow impulse turbine has been principally concerned with the identification and testing of brine-modification methods to prevent scale and solids deposition. Acidification is the method of primary interest. Chemistry and materials support for the Geothermal Loop Experimental Facility (GLEF) included research on characterization of brine and steam flows through the GLEF, development of an in-process scale-surveillance technique, development of sampling methods for suspended solids, and baseline characterization of the physical and chemical nature of the scale and solids produced. Methods for minimizing scale and solids deposition in the GLEF operation were studied; a plant materials test and evaluation program was initiated. (JGB)

10038 R and D of materials for geothermal power generation. Yamazaki, H. *Chinetsu Gijutsu;* No. 5, 39-47(Jan 1977). (In Japanese).

Six types of commercial anti-corrosion and anti-friction stainless steels to be used as materials for geothermal power generation were examined to determine their resistance to acidic hot water. Solutions of 0.1 mol/liter H_2SO_4 and solutions of 0.001 mol/liter and 0.01 mol/liter of H_2S in 0.1 molar H_2SO_4 were used as corrosive agents. A potential rate of 250 mV/min was applied at 19-21°C and the current density was measured. This experiment showed that austenitic stainless steel containing Cr and Ni was superior to ferrite type stainless steel containing Cr. A corrosion experiment was

performed in an autoclave at 200°C and 18 atm with the same result. The decrease in weight of SUS304 (18Cr-8Ni) was much less than that of SUS310 (25Cr-20Ni). Measurement of weight decrease of the materials in H_2SO_4 solutions (pH 1-2) and a saturated H_2S solution due to friction showed that SUS304 and SUS316 (18Cr-12Ni-2Mo) had excellent antifriction properties. Unfortunately, the austenitic stainless steels are too brittle for geothermal engineering applications. It was concluded that the ferritic steels must be improved in order to overcome these problems.

10039 Removal of hydrogen sulfide by an aeration method: on the prevention of some troubles caused by hydrogen sulfide in thermal water. Kanroji, Y. *Onsen Kogakkaishi;* **11**: No. 2-3, 73-77(1976). (In Japanese).

Problems caused by hydrogen sulfide in the utilization of thermal water include occlusion of conduit pipe by sulfur deposits, corrosion of metal materials by hydrogen sulfide, and poisoning of hydrogen sulfide gas. Removal of hydrogen sulfide by aeration is the most simple method for the prevention of these problems. Hydrogen sulfide in thermal water is often removed by flowing the water through a wide, shallow trough called "Yubatake." The Yubatake-aeration method is examined, and the relationship between the surface area of Yubatake and the decrease of hydrogen sulfide concentration is quantitatively analyzed.

10040 Geochemical equilibrium codes: a means of modelling precipitation phenomena in the Salton Sea Geothermal Field. Miller, D.G.; Piwinskii, A.J.; Yamauchi, R. (Univ. of California, Livermore). pp 167-172 of In SPE-AIME international symposium on oilfield and geothermal chemistry. New York; American Inst. of Mining, Metallurgical, and Petroleum Engineers, Inc. (1976).

From SPE-AIME international symposium on oilfield and geothermal chemistry; La Jolla, CA, USA (27 Jun 1977).

We have used the Helgeson-Herrick geochemical code to predict which minerals will precipitate from Salton Sea Geothermal Field brines. The code's predictions of sulfide-amorphous silica precipitation from the Magmamax No. 1 brine are in good agreement with field tests of scaling, although the observed silicate scale matrix is in amorphous form, rather than the numerous crystalline forms predicted by the code. The code's predictions of scale precipitation from wells with different brine compositions are also in good agreement with field tests. The code appears to be a useful screening tool, despite reservations about the use of purely thermodynamic predictions in systems with important kinetic constraints.

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

REFER ALSO TO CITATION(S) 10016, 10020, 10026

10041 (LBL—6369) **Results of reservoir evaluation tests, 1976 East Mesa Geothermal Field, California.** Narasimhan, T.N.; McEdwards, D.G.; Witherspoon, P.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1977. Contract W-7405-ENG-48. 11p. Dep. NTIS, PC A02/MF A01.

Two interference well tests, conducted at the U.S. Bureau of Reclamation's East Mesa geothermal test facility in Southern California by the Lawrence Berkeley Laboratory, serve to better define the geothermal reservoir's geometry and hydrologic characteristics. Temperature profiles taken indicate that the reservoir is approximately 3000 feet thick and is located about 6000 feet below the ground surface. The temperature at depth is approximately 350°C. The two well tests, each of approximately 10 days' duration yield respectively reservoir transmissivities of 11,200 and 29,500 millidarcy-feet and compressibilities of 5.7×10^{-3} and 2.1×10^{-3} feet per psi. The tests also indicate the possible presences of a sealed fault and a leaky fault in the reservoir.

10042 (NP—22631) **Effects of hot water reinjection on a production well. Research report No. 46.** Yamashita, K. (Kyushu Electric Power Co., Inc., Fukuoka (Japan). Research Dept.). Sep 1976. 16p. (In Japanese). TIC.

It was established that the reinjection of hot water from a production well at Otake had a considerable effect both on the performance of the well and the chemistry of the product. The flow of the hot water was traced using salt markers and the effect on the production well was studied. The amount of hot water from the production well was proportional to the quantity reinjected. The results are summarized in tables.

10043 (UCRL—50046-76, pp 127-171) **Earth sciences program.** 27 Apr 1977.

In LLL Geothermal Energy Program. Status report, January 1976—January 1977.

Research progress in the earth sciences studies on the Salton Sea Geothermal Field is reported under the following section headings: introduction; geological studies; geophysical studies—resource assessment, including resistivity survey, well-log resistivity evaluation, seismic refraction survey, and temperature-gradient analysis; reservoir engineering—resource assessment, including heat and mass transport in liquid-dominated geothermal reservoirs, thermal depletion of geothermal reservoirs with fracture and pore permeability, thermal history of injected effluents, evaluation of injection-well performance, and reservoir evaluation; and injection studies. (JGB)

10044 Inspection trip to Gosho Dam and Matsukawa geothermal power plant. Tachibana, K. (Resources and Energy Agency, Ministry of International Trade and Industry, JP). *Hatsuden Suiryoku;* No. 146, 120-122(1977). (In Japanese).

Matsukawa geothermal power plant went on line in 1966 with an initial output of 9.5 MW. After extensive research and development efforts on the part of Japan Metals and Chemicals Company, the output was raised to 22 MW by April, 1973. A total of seven productive steam wells are in operation. Well No. 1 first produced in January, 1964, and the most recent well (No. 7) in March, 1970. The depth, steam flow rate, pressure, temperature, and water:gas ratio of wells No. 1 through 7 are, respectively: 945 m, 45.3 t/h, 0.425 MPa, 196°C, and 99.59:0.41; 1080 m, 18.1 t/h, 0.420 MPa, 195°C, and 99.59:0.43; 1207 m, 61.7 t/h, 0.430 MPa, 205°C, and 99.22:0.74; 1190 m, 36.5 t/h, 0.420 MPa, 190°C, and 99.81:0.19; 1203 m, 26.6 t/h, 0.520 MPa, 170°C, and 99.68:0.32; and 1280 m, 0.525 MPa, 166°C, and 99.75:0.25.

10045 Studies on internal geothermal well measurement techniques. Takagi, S. *Chinetsu Gijutsu;* No. 4, 27-44(Oct 1976). (In Japanese).

In order to advance the utilization of geothermal energy for power generation it is necessary to develop new techniques for assessing complicated geological structures and thermal distributions, particularly by using data obtained from high temperature geothermal wells. The results of completed work and the nature of studies presently being carried out by the Sunshine Project are described. A realistic present goal should be the ability to make reliable measurements at 250°C and 200 kg/cm², although higher temperature conditions will probably be encountered frequently in the future. Specific studies were carried out on SP logging equipment, continuous flowmeters and heat/pressure proof containers during 1976. Several cross sectional drawings of the equipment developed are provided as is a schematic for the SP logging circuitry.

RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY

10046 Multiple-completion geothermal energy production systems. Van Huisen, A.T. US Patent 4,051,677. 4 Oct 1977. Filed date 3 Oct 1974. 10p.

A system is described for the mining of geothermal energy in which a plurality of geothermal wells radiate from a single surface site into a subsurface geothermal reservoir. The wells can be drilled by conventional slant drilling techniques, and each may contain a closed end heat exchanger which receives water and generates steam. Some of the heat exchangers are disposed vertically and others are implanted horizontally. By alternating production of the wells in a programmed cyclical manner, convective movement of the hydrothermal fluid will occur within the geothermal zone. The generated steam is collected in a reservoir at the surface site and utilized to generate electricity. The condensate from the turbine can be recycled to the wells.

DIRECT ENERGY UTILIZATION

REFER ALSO TO CITATION(S) 9996

10047 (SAN/1327—2) **Total Energy Recovery System for Agribusiness.** Fogleman, S.F.; Fisher, L.A.; Black, A.R.; Singh, D.P. (International Engineering Co., Inc., San Francisco, Calif. (USA)). May 1977. Contract EY-76-C-03-1327. 68p. Dep. NTIS, PC A04/MF A01.

An engineering and economic study was made to determine a practical balance of selected agribusiness subsystems resulting in realistic estimated produce yields for a geothermally heated system known as the Total Energy Recovery System for Agribusiness. The subsystem cycles for an average application at an unspecified hydrothermal resources site in the western United States utilize waste and by-products from their companion cycles insofar as practicable. Based on conservative estimates of current controlled environment yields, produce wholesale market prices, production costs, and capital investment required, it appears that the family-operation-sized TERSA module presents the potential for marginal recovery of all capital investment costs. In addition to family- or small-cooperative-farming groups, TERSA has potential users in food-oriented corporations and large-cooperative-agribusiness operations. The following topics are considered in detail: greenhouse tomatoes and cucumbers; fish farming; mushroom culture; biogas generation; integration meth-

odology; hydrothermal fluids and heat exchanger selection; and the system. 133 references. (MHR)

10048 Temperature variation in hot water line as a function of length. Gross, L. (Fernheizkraftwerk der ETH, Zurich, CH). *Fernwaerme Int.;* **6**: No. 4, 166-168(1977). (In German).

The determination of temperature variation (steady state) in a constant diameter transmission line through which an incompressible fluid flows is necessary in the design of district heating systems. In cases where lines are run through conduits or are buried in the ground, the ambient temperature can be treated as a constant. The long line can then be treated as a special heat exchanger in which flow resistance must be accounted for, and a differential equation must be used for solution. By simplification, the problem may be solved directly by integration. The introduction of index numbers into the equation enables the results to be easily interpreted.

GEOTHERMAL DATA AND THEORY

10049 Model for predicting the hydrostatic loading and unloading relationship of porous materials containing various amounts of fluid. Abey, A.E. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Geophys. Res.;* **82**: No. 33, 5418-5422(10 Nov 1977).

An elastic-inelastic model is presented for the loading and unloading pressure-volume relationship of porous materials containing various amounts of fluid from 0 to 100% saturation. Distributions in both size and separation of connected and unconnected spherical and connected penny-shaped pores are assumed. The number of pores with a given size is assumed to be inversely proportional to the initial volume and independent of the separation between pores. The simple relationships relating the radius of a pore to the applied pressure are discussed. The pressure-volume relationship for the porous material with any saturation is calculated by using the input parameters, shear strength, shear modulus, matrix and fluid pressure-volume relationships, and the pressure-volume data for the dry material. Model predictions agree with the experimental data within experimental error for all saturations and at pressures up to 4 GPa (40 kbar) for Mt. Helen tuff.

PROPERTIES OF AQUEOUS SOLUTIONS

REFER ALSO TO CITATION(S) 10040

PROPERTIES OF MINERALS AND ROCKS

10050 (ORNL-tr—4437) **Studies of the temperature dependency of the thermal conductivity of some rocks.** Seipold, U.; Gutzeit, W. Translated by T.W. Appich Jr. from *Gerlands Beitr. Geophys.;* **83**: No. 6, 498-504(1974). 8p. Dep. NTIS, PC A02/MF A01.

The principle of a method for determining the dependence of pressure on thermal diffusivity of rocks is described. Some possibilities for the preparation of samples were tested. The measurements were carried out on anhydrite, some sandstones, and granite. It has been stated that thermal diffusivity exhibits an approximately linear increase in the pressure range up to 3 kbar, however, the changes are not considerable. The pressure dependence of the thermal properties greately differs from the behavior of the elastic qualities (velocities of sound).

ROCK-WATER-GAS INTERACTIONS

10051 (UCID—17596) **Determination of the rate of formation of solids from hypersaline geothermal brine as a function of pH.** Harrar, J.E.; Otto, C.H. Jr.; Hill, J.H.; Morris, C.J.; Lim, R.; Deutscher, S.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Sep 1977. Contract W-7405-ENG-48. 10p. Dep. NTIS, PC A02/MF A01.

Preliminary results obtained in the analysis of the effluent brine from the LLL four-stage flash system are reported. Of principal interest was the rate of formation of suspended solids and the rate of decrease of dissolved silicon (or silica) in the solution as a function of the pH of the effluent brine. The experiments were conducted using Magmamax No. 1 brine at the LLL Test Facility near Calipatria, California. The wellhead brine (having a pH of approximately 5.7) was acidified in the flash system to pH values of 5.0, 4.0, and 3.0, +- 0.2 pH unit, and the solids and silica in the effluent at approximately 90°C were measured, respectively, by filtration and atomic absorption spectrophotometry. Changes in solids and silica concentration were determined after holding the brine at 90 +- 5°C for periods of time up to one week. Data from studies of the size distribution of suspended particles in three solutions are summarized.

TIDAL POWER

REFER ALSO TO CITATION(S) 10574, 10609

WIND ENERGY

WIND ENERGY ENGINEERING

TURBINE DESIGN AND OPERATION

10052 (STU—75-3260) **Wind energy generation for electric power production, preliminary studies. Part I.** Fischer, A. (Styrelsen foer Teknisk Utveckling, Stockholm (Sweden)). Mar 1976. 18p. (In Swedish). Dep. NTIS (US Sales Only), PC A02/MF A01.

Studies of wind power generation done by SAAB-Scania during 1975 are described. The project deals with generation of electricity for delivery to the transmission system. Both plants with horizontal axis and plants with vertical axis have been studied. A projected pilot plant with a rotor of 18 meter and an effect of 50 kW at 10 m/s wind velocity is described. Suggestions are made for a continuation of the project.

ELECTRIC POWER ENGINEERING

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 9596, 10606

10053 (COO—2477-7(Vol.1)) **Capital cost: high and low sulfur coal plants-1200 MWe.** (United Engineers and Constructors, Inc., Philadelphia, Pa. (USA)). 1977. Contract EY-76-C-02-2477. vp. (NUREG—0243(Vol.1)). Dep. NTIS, PC A17/MF A01.

This Commercial Electric Power Cost Study for 1200 MWe (Nominal) high and low sulfur coal plants consists of three volumes. The high sulfur coal plant is described in Volumes I and II, while Volume III describes the low sulfur coal plant. The design basis and cost estimate for the 1232 MWe high sulfur coal plant is presented in Volume I, and the drawings, equipment list and site description are contained in Volume II. The reference design includes a lime flue gas desulfurization system. A regenerative sulfur dioxide removal system using magnesium oxide is also presented as an alternate in Section 7 Volume II. The design basis, drawings and summary cost estimate for a 1243 MWe low sulfur coal plant are presented in Volume III. This information was developed by redesigning the high sulfur coal plant for burning low sulfur sub-bituminous coal. These coal plants utilize a mechanical draft (wet) cooling tower system for condenser heat removal. Costs of alternate cooling systems are provided in Report No. 7 in this series of studies of costs of commercial electrical power plants.

10054 (COO—2477-7(Vol.2)) **Capital cost: high and low sulfur coal plants-1200 MWe.** (United Engineers and Constructors, Inc., Philadelphia, Pa. (USA)). 1977. Contract EY-76-C-02-2477. vp. (NUREG—0243(Vol.2)). Dep. NTIS, PC A14/MF A01.

This Commercial Electric Power Cost Study for 1200 MWe (Nominal) high and low sulfur coal plants consists of three volumes. The high sulfur coal plant is described in Volumes I and II, while Volume III describes the low sulfur coal plant. The design basis and cost estimate for the 1232 MWe high sulfur coal plant is presented in Volume I, and the drawings, equipment list and site description are contained in Volume II. The reference design includes a lime flue gas desulfurization system. A regenerative sulfur dioxide removal system using magnesium oxide is also presented as an alternate in Section 7 Volume II. The design basis, drawings and summary cost estimate for a 1243 MWe low sulfur coal plant are presented in Volume III. This information was developed by redesigning the high sulfur coal plant for burning low sulfur sub-bituminous coal. These coal plants utilize a mechanical draft (wet) cooling tower system for condenser heat removal. Costs of alternate cooling systems are provided in Report No. 7 in this series of studies of costs of commercial electrical power plants.

10055 (COO—2477-7(Vol.3)) **Capital cost: high and low sulfur coal plants-1200 MWe.** (United Engineers and Constructors, Inc., Philadelphia, Pa. (USA)). 1977. Contract EY-76-C-02-2477. vp. (NUREG—0243(Vol.3)). Dep. NTIS, PC A13/MF A01.

This Commercial Electric Power Cost Study for 1200 MWe (Nominal) high and low sulfur coal plants consists of three volumes. The high sulfur coal plant is described in Volumes I and II, while Volume III describes the low sulfur coal plant. The design basis and

cost estimate for the 1232 MWe high sulfur coal plant is presented in Volume I, and the drawings, equipment list and site description are contained in Volume II. The reference design includes a lime flue gas desulfurization system. A regenerative sulfur dioxide removal system using magnesium oxide is also presented as an alternate in Section 7 V olume II. The design basis, drawings and summary cost estimate for a 1243 MWe low sulfur coal plant are presented in Volume III. This information was developed by redesigning the high sulfur coal plant for burning low sulfur sub-bituminous coal. These coal plants utilize a mechanical draft (wet) cooling tower system for condenser heat removal. Costs of alternate cooling systems are provided in Report No. 7 in this series of studies of costs of commercial electrical power plants.

10056 **New design concept for wide range controls.** Glattfelder, A.H. (Tech Hochsch, Zurich, Switz). *VGB Kraftwerkstech.;* **55**: No. 7, 428-431(Jul 1975). (In German with English abstract).

Following the prevalent position in the power plant field of the linear control technique for the control of direct operation, process control in the wide range is also being automated to an increasing extent. In addition to various protection devices, automatic control equipment for start-up and shut-down and also controllers for large rapid load changes are in service. Diagrams show concept.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

REFER ALSO TO CITATION(S) 9654, 10730

10057 (BNWL—2180(Vol.1)) **User's manual for the BNW-I optimization code for dry-cooled power plants. Volume I.** Braun, D.J.; Daniel, D.J.; De Mier, W.V.; Faletti, D.W.; Wiles, L.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1977. Contract EY-76-C-06-1830. 212p. Dep. NTIS, PC A10/MF A01.

This User's Manual provides information on the use and operation of three versions of BNW-I, a computer code developed by Battelle, Pacific Northwest Laboratory (PNL) as a part of its activities under the ERDA Dry Cooling Tower Program. These three versions of BNW-I were used as reported elsewhere to obtain comparative incremental costs of electrical power production by two advanced concepts (one using plastic heat exchangers and one using ammonia as an intermediate heat transfer fluid) and a state-of-the-art system. The computer program offers a comprehensive method of evaluating the cost savings potential of dry-cooled heat rejection systems and components for power plants. This method goes beyond simple "figure-of-merit" optimization of the cooling tower and includes such items as the cost of replacement capacity needed on an annual basis and the optimum split between plant scale-up and replacement capacity, as well as the purchase and operating costs of all major heat rejection components. Hence, the BNW-I code is a useful tool for determining potential cost savings of new heat transfer surfaces, new piping or other components as part of an optimized system for a dry-cooled power plant.

10058 (BNWL—2180(Vol.3)) **User's manual for the BNW-I optimization code for dry-cooled power plants. Volume III.** Braun, D.J.; Daniel, D.J.; De Mier, W.V.; Faletti, D.W.; Wiles, L.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1977. Contract EY-76-C-06-1830. 170p. Dep. NTIS, PC A08/MF A01.

This appendix to User's Manual for the BNW-1 Optimization Code for Dry-Cooled Power Plants provides a listing of the BNW-I optimization code for determining, for a particular size power plant, the optimum dry cooling tower design using a plastic tube cooling surface and circular tower arrangement of the tube bundles. (LCL)

10059 (BNWL—2180(Vol.4)) **User's manual for the BNW-I optimization code for dry-cooled power plants.** Braun, D.J.; Daniel, D.J.; De Mier, W.V.; Faletti, D.W.; Wiles, L.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1977. 197p. Dep. NTIS, PC A09/MF A01.

This appendix provides a listing, called Program AMCIRC, of the BNW-I optimization code for determining, for a particular size power plant, the optimum dry cooling tower design using ammonia flow in the heat exchanger tubes. The optimum design is determined by repeating the design of the cooling system over a range of design conditions in order to find the cooling system with the smallest incremental cost. This is accomplished by varying five parameters of the plant and cooling system over ranges of values. These parameters are varied systematically according to techniques that perform pattern and gradient searches. The dry cooling system optimized by program AMCIRC is composed of a condenser/reboiler (condensation of steam and boiling of ammonia), piping system (transports ammonia vapor out and ammonia liquid from the dry cooling towers), and circular tower system (vertical one-pass heat exchangers situated in circular configurations with cocurrent ammonia flow in the tubes of the heat exchanger). (LCL)

POWER CYCLES

REFER ALSO TO CITATION(S) 10583

10060 (CONF-7605161—, pp 350-354) **Pressurised fluidized-bed combustion with special reference to open gas turbines.** Harboe, H.; Maude, C.W. (Stal-Laval Ltd., London). 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

The principle of fluidized-bed combustion is described, and the case is made for building a 70-MW coal-fired gas turbine with pressurized fluidized-bed combustor/air heaters. Further potential developments to larger combined-cycle units is mentioned.

10061 (FE—1521-27) **Design report. Volume 8. Section 600: gas turbine and waste heat boiler.** (Foster Wheeler Energy Corp., Livingston, N.J. (USA)). Oct 1977. Contract EX-76-C-01-1521. 296p. Dep. NTIS, PC A13/MF A01.

Two components, i.e., the gas turbine generator and waste heat boiler, of a proposed advanced design combined cycle power plant with an integrated coal gasification system are discussed. The gas turbine generator includes the turbine itself, the generator, an air filter and silencer, control system, and all necessary auxiliaries, such as fuel oil pump and atomizing air compressor. The waste heat exchanger (boiler) package includes the waste heat exchanger (boiler), steam drum, circulating pumps, ducting and drum level controls, and stack. Equipment specifications for these two components, for a blowdown flash drum, and for instrumentation required for operating the components are presented. (LCL)

10062 (FE—2290-28) **High Temperature Turbine Technology Program. Phase I. Program and system definition. Topical report: low Btu fuel combined cycle reference design.** (Westinghouse Electric Corp., Lester, Pa. (USA). Generation Systems Div.). Feb 1977. Contract EX-76-C-01-2290. 228p. Dep. NTIS, PC A11/MF A01.

This report presents a systems design description for a combined cycle based on a High Temperature Turbine Technology, 2600°F combustion turbine operating with a coal-derived low-Btu fuel gas. The overall plant design is based on Westinghouse combined cycle PACE experience and achieves a calculated heat rate of 8,336 Btu/KwHr at a power output of 925 megawatts. The power generating system consists of four combustion gas turbines and one 2400 psig/1000°F reheat steam turbine. Each gas turbine train includes an unfired heat recovery steam generator, an on-site gasification system and a cold gas cleanup system. The information presented supplements the Overall Plant Design Description and further defines power generating and gasification components and auxiliaries, balance of plant systems and plant control concepts to the extent necessary to establish the technical feasibility of incorporating this high temperature combined cycle and gasification process into an operating plant system. A preliminary reliability assessment of the plant in the form of Failure Mode Effects and Criticality Analyses and plant availability is included, together with a plan for evaluating the plant maintainability. Site and plant layouts establish the size and the physical relationship between major systems.

10063 (FE—2352-3) **Gasification combined cycle test facility, Pekin, Illinois. Monthly technical progress report, July 1977.** (Commonwealth Research Corp., Chicago, Ill. (USA)). Aug 1977. Contract EF-77-C-01-2352. 20p. Dep. NTIS, PC A02/MF A01.

Progress in developing a prototype combined-cycle power plant which includes a coal gasification plant is reported. Information is included on meetings held; completion of procurement procedures; gas turbine, compressors, blowers, and heat exchanger; specifications for heat recovery steam generators and auxiliary equipment; control systems; electrical equipment; and vessels. (LCL)

COMPONENTS

REFER ALSO TO CITATION(S) 10061, 10368, 10656

10064 (AED-Conf—76-595-004) **New developments in order to avoid blade erosion in low-pressure final stages.** von Schwerdtner, O.A.; Hosenfeld, H.G. (Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). 1976. 38p. (In German). (CONF-761189—1). Dep. NTIS (US Sales Only), PC A03/MF A01.

From VGB specialists meeting on steam turbines and steam turbine operation; Hamburg, F.R. Germany (12 Nov 1976).

The possibility of damaging the final-stage rotor blades in condensing reheat turbines by erosion caused by impingement of drops could be presented by thermodynamic and constructional measures. The development of two measures, namely removal of harmful condensate from the final-stage fixed blades by suction or heating is described and the results are reported.

10065 (FE—1237-47) **Multicell fluidized-bed boiler design, construction, and test program. Quarterly progress status report, Octo-**

ber—December 1975. Mesko, J.E. (Pope, Evans and Robbins, Inc., New York (USA). Combustion Systems Div.). Jan 1976. Contract EX-76-C-01-1237. 84p. Dep. NTIS, PC A05/MF A01.

The objective of this program is to design, construct and test a multicell fluidized-bed boiler, as a pollution-free method of burning high-sulfur coal, or burning highly corrosive coals without excessive maintenance problems, with an approximate steam generating capacity of 300,000 pounds per hour. Steam pressure and temperature conditions were selected to meet requirements of the site at which the boiler is being installed. The effects of (1) additions of salt, sodium carbonate and (2) of different sources of limestone on the efficiency of reducing sulfur dioxide in the stack gases are reported. The fabrication, installation and testing of various components is itemized. Experiments involving the use of spent bed material as fertilizer for peanut and corn crops were encouraging. Even at high application rates the bed material was not toxic to the crops tested. (LTN)

10066 (FE—2471-13) **Industrial application fluidized bed combustion. Category III. Indirect fired heaters. Monthly technical report No. 9, July 1—31, 1977.** Cherrington, D.C. (Exxon Research and Engineering Co., Florham Park, N.J. (USA). Engineering and Technology Dept.). 10 Aug 1977. Contract EX-76-C-01-2471. 23p. Dep. NTIS, PC A02/MF A01.

The test program on the Two-Dimensional Flow Visualization Unit is proceeding as planned. The testing of the 2-in.-dia tube Rivesville bundle configuration has been completed. The second test bundle made up of 6-in.-dia tubes on 3-in.-dia tube center-to-center spacing is now installed and is being evaluated. Initial conductive/convective heat transfer data have been obtained on the 2-in.-dia Rivesville bundle. The assembly and checkout of the Process Stream Coking Unit is essentially completed and disassembly for transfer of the unit to the Bayway Refinery test site will begin on August 1. Civil, electric, and piping work within the Refinery in preparation for placement of the unit is underway. Vendor proposals for major critical path equipment components for the Fluidized Bed Heat Flux Unit have been received and analyzed. Placement of orders is being held, pending final release and approval by the ERDA.

10067 (NP—22497) **Accurate determination of gas turbine performance under different operational conditions.** Lindberg, G. (Tekniska Hoegskolan, Lund (Sweden)). 1975. 158p. Dep. NTIS (US Sales Only), PC A08/MF A01.

Compared to the well-known methods used when testing a steam power plant there are no similar methods which are generally accepted, when determining the performance of a gas turbine unit. To achieve the necessary systematization dictated by the complexity of the subject the presentation is made in three separate parts. In the first part there are different mathematical models to be found which are applicable to the thermodynamic changes of state taking place in a gas turbine. Furthermore, a number of accurate suggestions are given as to how to evaluate the performance of a gas turbine from actual test runs. Here particular effort has been made to analyze and assess the suitability of the models to be used by a computer. One of the features of the gas turbine is the strong dependence of the ambient condition which is a complication from the view of determining the performance. Methods to solve this problem are presented for both multi-shaft and single-shaft gas turbines. The second part deals with the practical verification of the models in part one. Thus, a number of calculation results from measurements on gas turbines of different designs are presented. By this the general validity of the theoretical methods have been proved. Finally, in the third part, the results of a large number of test runs of actual gas turbines are compiled and summarized in a number of valuable recommendations for people involved in the formulation of gas turbine contracts.

10068 **Corrosion aspects in designing power plant equipment.** Winkler, R. (VEB Kernkraftwerk Bruno Leuschner, Greifswald (German Democratic Republic)). *Energietechnik;* **27**: No. 3, 109-113(Mar 1977). (In German).

From 8. meeting on power plant engineering; Dresden, German Democratic Republic (19 Oct 1976).

The influence of design on corrosion behavior of power plant equipment is discussed. The main types of corrosion are reviewed and the use of information obtained from failure analysis for designing is emphasized.

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 10614, 10656

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 10604

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 9648, 9649, 10654

POWER TRANSMISSION AND DISTRIBUTION

10069 (EPRI-EL—147) **Free and forced convective cooling of pipe-type electric cable systems.** Chato, J.C. (Illinois Univ., Urbana (USA). Dept. of Mechanical Engineering). Aug 1977. Contract EX-76-C-01-1568. 191p. Dep. NTIS, PC A09/MF A01.

The major objective of these analytical and experimental investigations was to develop mathematical and physical models that would provide accurate knowledge of the hydrodynamic and thermal characteristics of convectively cooled, pipe-type electric cables. The various cable system components were analyzed separately to determine their respective influence on heat transfer. Enhanced transfer of heat to the oil, uniform cooling of the insulation, and reduced pressure drop/friction factor were the major problem areas investigated.

10070 **Flow directing means for air-cooled tranformers.** Jallouk, P.A. (to Energy Research and Development Administration). US Patent 4,032,873. 28 Jun 1977. Filed date 21 May 1976. 6p.

PAT-APPL-688,871.

Improvements in systems for force-cooling transformers are described. An outer helical winding and an insulation barrier form an axially extending annular passage for cooling-fluid flow. A tubular shroud is positioned about the helical winding to define an axially extending annular chamber for cooling-fluid flow. The chamber has a width in the range of from about 4 to 25 times that of the axially extending passage. Two baffles extend inward from the shroud to define with the helical winding two annular flow channels having hydraulic diameters smaller than that of the chamber. The inlet to the chamber is designed with a hydraulic diameter approximating that of the coolant-entrance end of the above-mentioned annular passage. As so modified, transformers of the kind described can be operated at significantly higher load levels without exceeding safe operating temperatures. In some instances the invention permits continuous operation at 200 percent of the nameplate rating.

10071 (GEFR-TR—002) **Methods for creation of high-voltage, high-temperature electric insulation.** Kalitvyanskii, V.I.; Tuchinskii, A.M.; Aleksandrov, M.N.; Asnovich, E.Z.; Kolganova, V.A. Translated from *Elektrotekhnika;* **43**: No. 5, 10-12(1972). 7p. Dep. NTIS, PC A02/MF A01.

Methods for the production of high voltage (up to 6 kV) and high temperature (500 to 600°C) electric insulation were studied. Insulation of this class can be produced using artificial mica and aluminophosphate.

AC SYSTEMS, EHV AND UHV

10072 (CONF-7605161—, pp 266-272) **Predicted lightning performance of 1000-, 1300-, and 1500-kV uhv transmission lines.** Darveniza, M. (Univ. of Queensland, St. Lucia, Australia). 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

The results are presented of calculations of the shielding and backflash performance of the proposed 1000, 1300, and 1500 kV transmission lines. The calculations were made using analytical methods developed for and validated on HV and EHV lines. Zero lightning outage rates are predicted for the UHV lines with average footing resistances up to 40 ohms. However, a significant number of sub-critical shielding failures are expected with the conventional 2-overhead earthwire system, but these are not likely to cause flashover of line insulation. 7 tables, 5 figs., 12 refs.

10073 (EPRI-EL—537) **Controlled impedance short circuit limiter. Research report 654.** Paice, D.A.; Zubek, J.; Bonk, J.; Putkovich, R.P. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Design and Development Center). Sep 1977. 201p. Dep. NTIS, PC A10/MF A01.

Continued growth of electrical power systems and the consequent increase in fault currents has produced the need for current limiting devices. The objective of this program was to investigate the technical and economic factors associated with one particular fault current technique, the controlled impedance current limiter. In this method, a series tuned inductor-capacitor circuit, placed in the line, has virtually zero impedance under normal operation; however, during a fault the series tuned configuration is rapidly altered into a high resistive impedance. Five circuit variations of this limiter were examined. Performance of the resonant circuit limiters was analyzed and evaluated by using a digital computer simulation and by tests on a scaled-down model. The computer simulation was based on a power system application having a throughput rating of 300 MVA at

a nominal system voltage of 145 kV. The results of this study, however, are applicable for limiters in 69 kV to 345 kV systems. The major parameters of interest were the first cycle peak let-through current, steady state limited fault current, and peak component stresses. With this current limiter, the fault current has relatively little offset and the instantaneous peak let-through current can be held to about 10 times rated current. The fault current after one cycle is typically held to 2 times rated current and is resistive (0° phase angle). The major components of the limiter are conventional inductors and capacitors. Typically, a limiter module having a 100 MVA throughput rating occupies a space of 34 x 26 x 20 ft. The costs vary between $1500 to $3900 per MVA. If this cost can be justified, the application, in view of its losses (approximately 0.1%) is especially attractive on a bus tie where its low load factor imposes a minimum of penalty. Furthermore, the strong current limiting performance coupled with resistive follow-through current results in minimum fault current contribution to the system.

10074 (ORNL-tr—4448) **Woodpecker damage in wooden power-line poles.** Andersson, E.W. Translated by S.D. Blalock Jr. from *Tek. Tidskr.;* **83**: 7-10(1953). 8p. Dep. NTIS, PC A02/MF A01.

The damage to wooden power poles caused by woodpeckers was investigated. Approximately 170 damaged poles with 460 holes were studied to determine the size, location, and configuration of the holes and suitable methods for protecting wooden poles. It was concluded that a metal mesh screen with a mesh width of 10 mm or less is the best protective device for solving this problem. (LCL)

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

10075 Superconducting cable cooling system by helium gas at two pressures. Dean, J.W. (to Energy Research and Development Administration). US Patent 4,020,275. 26 Apr 1977. Filed date 27 Jan 1976. 8p.

PAT-APPL-649,888.

Thermally contacting, oppositely streaming, cryogenic fluid streams in the same enclosure in a closed cycle changes the fluid from a cool high pressure helium gas to a cooler reduced pressure helium gas in an expander so as to be at different temperature ranges and pressures respectively in go and return legs that are in thermal contact with each other and in thermal contact with a longitudinally extending superconducting transmission line enclosed in the same cable enclosure that insulates the line from the ambient at a temperature T_1. By first circulating the fluid from a refrigerator at one end of the line as a cool gas at a temperature range T_2 to T_3 in the go leg, then circulating the gas through an expander at the other end of the line where the gas becomes a cooler gas at a reduced pressure and at a reduced temperature T_4 and finally by circulating the cooler gas back again to the refrigerator in a return leg at a temperature range T_4 to T_5, while in thermal contact with the gas in the go leg, and in the same enclosure therewith for compression into a higher pressure gas at T_2 in a closed cycle, where T_2 greater than T_3 and T_5 greater than T_4, the fluid leaves the enclosure in the go leg as a gas at its coldest point in the go leg, and the temperature distribution is such that the line temperature decreases along its length from the refrigerator due to the cooling from the gas in the return leg.

10076 Superconducting cable cooling system by helium gas and a mixture of gas and liquid helium. Dean, J.W. (to Energy Research and Development Administration). US Patent 4,020,274. 26 Apr 1977. Filed date 27 Jan 1976. 8p.

PAT-APPL-649,887.

Thermally contacting, oppositely streaming cryogenic fluid streams in the same enclosure in a closed cycle that changes from a cool high pressure helium gas to a cooler reduced pressure helium fluid are comprised of a mixture of gas and boiling liquid so as to be near the same temperature but at different pressures respectively in go and return legs that are in thermal contact with each other and in thermal contact with a longitudinally extending superconducting transmission line enclosed in the same cable enclosure that insulates the line from the ambient at a temperature T_1. By first circulating the fluid in a go leg from a refrigerator at one end of the line as a high pressure helium gas near the normal boiling temperature of helium; then circulating the gas through an expander at the other end of the line where the gas becomes a mixture of reduced pressure gas and boiling liquid at its boiling temperature; then by circulating the mixture in a return leg that is separated from but in thermal contact with the gas in the go leg and in the same enclosure therewith; and finally returning the resulting low pressure gas to the refrigerator for compression into a high pressure gas at T_2 is a closed cycle, where T_1 greater than T_2, the temperature distribution is such that the line temperature is nearly constant along its length from the refrigerator to the expander due to the boiling of the liquid in the mixture. A heat exchanger between the go and return lines removes the gas from the liquid in the return leg while cooling the go leg.

NUCLEAR POWER PLANTS

10077 (CONF-7605161—, pp 99-109) **Nuclear process heat for sea water desalination plant.** Kemeny, L.G. 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

The provision of high quality fresh water to meet peak demands at times of drought in large population centers and to satisfy the requirements for water standards in industrial processes is perhaps the prime attraction of thermal sea water desalination plant. Australia, the driest of earth's continents, will probably have a need for such water supply supplementation and industrial process application long before desalting is applied generally to agriculture or rural production. As the cost of fossil fuel gradually increases, it would also seem likely that the thermal energy required for desalting will come from nuclear fuels. In this paper the existing fresh water resources of the Australian continent are briefly surveyed. Present costs associated with supplying fresh water for industrial and domestic consumption to selected communities at representative locations of the Australian continent are assessed. The technology and economics of large scale sea water desalination plant operating on thermal cycles are discussed. In particular, the multi-stage flash evaporator principle is reviewed and its potential discussed. Consideration is given to the advantages and disadvantages of nuclear powered heat sources. Proposals are made for the control and conjunctive use of reservoirs and desalination plant. The optimization of desalination plant size and its integration with reservoir storage schemes in two potential Australian locations is discussed.

10078 (NP—22078) **Nuclear power and the Canadian public.** Greer-Wootten, B.; Mitson, L. (York Univ., Toronto, Ontario (Canada). Inst. for Behavioural Research). Jun 1976. 418p. Dep. NTIS (US Sales Only), PC A18/MF A01.

The purpose of the study was to ascertain the opinions and attitudes of Canadians to the use of nuclear power for generating electricity, as an initial step in developing information programs attuned to the demonstrated needs of the public. This report presents the findings from the survey of the Canadian public aged 18 years and over. Over 2100 persons responded to our interviewers, generating about 200,000 answers to the questions.

10079 (PGE—8003(Rev.2)) **Nuclear Projects Quality Assurance program for design, construction, and preoperational testing.** (Portland General Electric Co., Oreg. (USA)). Sep 1977. vp. General Electric Co., OR.

The Portland General Electric Company Quality Assurance Program for the design, procurement, construction, and preoperational testing of nuclear power plants is presented. The program describes the organizational structure for quality assurance; identifies the functions, duties, and responsibilities of key departments and individuals; describes interrelationships and interfaces among internal groups and external organizations; delineates quality program requirements; and prescribes methods of implementation.

10080 Nuclear power - the real problems and the emotional issues of the public debate. Hill, J. (UKAEA). *Atom (London);* No. 249, 126-131(Jul 1977).

Lecture given at York Univ., UK on 19 May 1977.

This lecture, given by the Chairman of the UK Atomic Energy Authority, was based on the following main considerations - (1) the world energy situation and the need for nuclear power; (2) the case for plutonium and the fast reactor, these issues being central to the present controversy regarding the future of nuclear power; (3) the forthcoming public debate on nuclear power and its real issues.

10081 Changes in electricity generation in 17 European countries for the 'twelfth year' up to September 1976. Frohnholzer, J. (Energietechnik G.m.b.H., Muenchen (Germany, F.R.)). *Elektrizitaetswirtschaft;* **76**: No. 11, 315-326(May 1977). (In German).

In continuation of a report on electricity generation in 17 European countries for the period between October 1963 und September 1975 in 'Elektrizitaetswirtschaft' vol. 75(1976), pp 126 to 144, the author now deals with the changes in electricity generation in the countries of the western unions for the time between October 1975 and September 1976. He indicates for the winter six months and for the summer period the relations between the possible generation in hydroelectric station, the air temperatures and the quantities generated in the thermal stations. He gives examples of countries with reductions in hydroelectric generation in the excessively dry and hot summer of 1976. The stored quantities and the fuel reserves at the end of the report period and the changes from the preceding year are given. The development of thermal generation and the contributions of nuclear energy are given for those 8 countries which operate their own nuclear stations.

10082 Power reactors '77. Annual directory of data on the world's power reactors. *Nucl. Eng. Int.;* **22**: No. 258, p.(Apr 1977).

A directory is presented of data on the world's power reactors. An alphabetical listing of stations gives cross-reference to three main sections which tabulate general information, technical data, and progress schedules.

10083 Nuclear fuel cycle. IV. The reactors. Farmer, A.A. (UKAEA Reactor Group, Risley). *J. Inst. Fuel;* **50**: No. 402, 33-40(Mar 1977).

The main type of nuclear reactors available for electricity generation are briefly described, i.e. Magnox, AGR, high-temperature reactors, PWR, BWR, Candu-type, SGHWR, and fast reactors. A general comparison is made of some of the features of the thermal reactors presently operating and their relative merits are indicated. Future possible fuel strategies are mentioned.

10084 Operational experience with nuclear power installations in the Federal Republic of Germany. Annual report for 1976 of the ABE-committee of working party I 'Engineering and Industry' of the German Atom Forum. *At. Strom;* **23**: No. 2, 21-48(Mar 1977). (In German).

In this report a comprehensive review is given of operational results achieved with the nuclear power stations functioning in the Federal Republic of Germany during 1976. The individual plants are discussed in separate chapters. The annual performance curve (availability) for each reactor is presented in a diagram.

10085 Standard operation manual for nuclear power stations. Ergonomic and work-technological questions, first experiences. Beuerle, H.J. (Gemeinschaftskernkraftwerk Neckar G.m.b.H., Neckarwestheim (Germany, F.R.)); Stoll, A. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). *VGB Kraftwerkstech.;* **57**: No. 3, 145-151(Mar 1977). (In German).

The operating manual is regarded as an essential instrument for the control of planning and assembly for commissioning and as an instruction manual contributing decisively towards the training of the operating staff. There is a causal relation between the operating manual and the operating license. Understanding between the licensing authorities, operators and manufacturers is always much better if the mode of operation and the planned control of the remotest possible hypothetical trouble are explained in detail.

10086 Nuclear power plant services as seen by a power plant supplier. Lochmann, K.H. (Kraftwerk Union A.G., Offenbach (Germany, F.R.)). *Kerntechnik;* **19**: No. 3, 105-109(Mar 1977). (In English, German).

The main objective of Nuclear Plant Services is to support the nuclear power plant operators in their efforts to ensure economy of operation of their plants while maintaining the high safety standard of nuclear power plants. The services rendered by the power plant suppliers are exemplified by evaluation of operating experience for information feedback and product service, standard services such as in-service inspections and fuel services, assistance in the case of incidents, accidents and repairs, backfitting of operating plants, performance of theoretical studies and preparation of additionally required licensing documents. The suppliers of nuclear power plants attach great importance to nuclear plant services and are continously improving them still further.

10087 Nuclear systems inspection services. Selig, B.J. (Combustion Engineering, Inc., Windsor, Conn. (USA)). *Kerntechnik;* **19**: No. 3, 110-116(Mar 1977).

There are numerous inspections performed on a nuclear system during refuelling outages. This article will concentrate on results of actual field testing and will include also a description of the equipment and approach utilized in three specific inspection areas: fuel, steam generators and inservice inspection (nondestructive examination of the primary system boundary). In addition to actual results, the development and utilization of the specialized tools to perform these inspections will be described together with the impact on refuelling schedules and man-rem exposures.

10088 Atom and democracy. Remond, R. *Rev. Gen. Nucl.;* No. 1, 6-8(1977). (In French).

Analyzing the relations established between public opinion and nuclear energy, it is considered that it will be impossible to develop the use of this type of energy without the approval of the citizens. This approval, which assumes that the definition of the energetic choices is not seized by 'technicians' whatever their authority, is a basic condition for democracy. It involves a huge informational and public education effort so that everyone is able to have an objective opinion on a type of energy which now rises more passioned than reasoned reactions.

10089 Investigation of echoes in reactor fluctuation analysis. Saxe, R.F. (North Carolina State Univ., Raleigh (USA). Dept. of Nuclear Engineering). *Ann. Nucl. Energy;* 4: No. 2, . 69-78(1977).

The detection and measurement of echoes occurring in the measured parameters of a pressurized water reactor has been investigated. It is shown that echoes do occur and can be measured. It is also shown that a distortion of these echoes can materially affect the measured coherences between pairs of signals. The origins of the echoes have not yet been investigated.

10090 Proposed strategy for power reactor development lets P.N.C. down. *At. Jpn.;* **20**: No. 8, 6-11(Aug 1976).

The strategy for power reactor development in Japan is discussed. The development of nuclear power is at the stage of requiring larger funds than ever. The developments of the prototype heavy water reactor Fugen and the experimental fast reactor Joyo are at the point of planning the next stages. The high temperature gas reactor project must be forwarded. The fuel cycle picture is a serious problem in Japan, and the national project on the development of heavy water reactors was started, and has been developed by the Power Reactor and Nuclear Fuel Development Corporation (PNC). However, the users criticized this project. The prototype heavy water reactor will be in operation next year, and it will be after the prototype construction, switching should be made to a thorium-fueled reactor. Discord in the basic strategy for power reactor development arises from a plan to introduce CANDU reactors.

10091 Atomic science and engineering in the economy of the Soviet Union. Kruglov, A.K. *At. Energ. (USSR);* **40**: No. 2, 103-116(Feb 1976). (In Russian).

The main achievements of Soviet atomic science and engineering are presented. Due to the development of the atomic industry, it is possible to produce at atomic stations cheaper energy in kWh cost than at thermal electrical stations. The successful operation of the VVER reactor at the Novo Voronezh Atomic Station and the RBMK reactor at the Leningrad Atomic Station, makes it possible to proceed to the development of more economic thermal reactors with a unit power over 1,500,000 kW. Methods are analysed allowing the atomic industry to be supplied with cheap nuclear fuel on the basis of poor uranium ores. The introduction of radioactive isotopes into the national economy has allowed a number of industries to automate control, to improve technologies and safety measures, etc. Isotopes are being more and more widely used in medicine. Some aspects are considered of using nuclear explosions in the gas and oil industry, in constructing hydraulic engineering works and creating places for the disposal of harmful or radioacmive wastes.

10092 Addition of nuclear power station to the A.R.E. power system. 1. Reliability studies. El-Tablawi, T.A.; Molokhia, I.M.; Radwan, R.; Ibrahim, Y.M. (Atomic Energy Establishment, Inshas (Egypt)). *Arab J. Nucl. Sci. Appl.;* **9**: No. 2, 139-153(Feb 1976).

The addition of the first nuclear power station to the A.R.E. Power system has been investigated. The timing of the addition and the size of the unit have been determined using the reliability method. The choice of the size has been selected to satisfy the predetermined reliability level (0.9992) while keeping the spinning reserve requirements to a minimum. However, the study recommended that two units of 300 MW each are more economical than one unit of 600 MW capacity.

10093 System for 'quality assurance' at the E.D.F. (French Electricity-Board) for nuclear power stations. Vaujour, J.A. (Electricite de France, 75 - Paris. Direction de l'Equipement); Feger, M. (Electricite de France, 93 - Saint-Denis. Service de la Production Thermique). *Rev. Gen. Nucl.;* No. 4, 308-312(1976). (In French).

The system for assuring quality set up by the E.D.F. for the building of nuclear power stations is described. After defining the general principles for ensuring quality and after specifying the distribution of the tasks established between the E.D.F. and its suppliers it is dealt with the design of the plants, the manufacture of the equipment, construction on the site, tests and operation. The putting into application of this system has been positive, both technically and from the viewpoint of organization.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 10369, 10374, 10380, 10389, 10390, 10391, 10392, 10399, 10400, 10433, 10439, 10466, 10467

10094 (BARC—914) **Comparative study of zircaloy and stainless steel as cladding material for pressurised water reactor.** Ganguly, C.; Roy, P.R. (Bhabha Atomic Research Centre, Bombay (India)). 1977. 74p. Dep. NTIS (US Sales Only), PC A04/MF A01.

A comparative study of cladding material, stainless steel (Type 304, 347/348) and zircaloy (2 and 4) for oxide fuels of uranium, plutonium and mixed uranium-plutonium in pressurised light water cooled and moderated thermal reactor is made based on factors like: (1) neutron economics, (2) corrosion resistance, (3) chemical interaction with fuel, impurities and fission products, (4)

pellet clad mechanical interaction- tensile, creep and fatigue properties, and (5) overall performance. Though the physical and mechanical properties and also the in-reactor performance record of stainless steel is better than zircaloy, the better neutron economics with zircaloy, because of its twelve times less neutron absorption cross section, overrides all the advantages of stainless steel. As a result all P.W.R.s are switching over to Zircaloy claddings. To achieve the failure rate as low as those for stainless steel the zircaloy fuel elements need modifications like use of smaller diameter pins with greater wall thickness, graphite of siloxane coating of clad internal surface, fuel pin pre-pressurisation, vacuum hot drying of pellets prior to loading and final end capping, use of short (length/diameter = 1 maximum), dished, chamferred, high density fuel pellets with uniformly distributed pores and enough diametral gap between pellet and clad.

10095 (CONF-770902—5) **Loose-parts monitoring: present status of the technology, its implementation in U.S. reactors, and some recommendations for achieving improved performance.** Kryter, R.C.; Ricker, C.W.; Jones, J.E. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 6p. Dep. NTIS, PC A02/MF A01.

From Specialists meeting on reactor noise; Gatlinburg, Tennessee, USA (19 Sep 1977).

An assessment of the technical development status of loose-parts monitoring systems (LPMS) and their performance record to data in commercial light-water-cooled nuclear reactor plants was made during the spring of 1977, using an on-site personal interview and equipment demonstration approach. The study revealed that while presently demonstrated LPMS technology does indeed provide a capability for detecting the presence of those relatively massive loose parts that would likely constitute a serious operational or safety hazard to the plant, it unfortunately affords little information useful to the determination of the parts' safety significance and has not yet attained the levels of sophistication and reliability ordinarily associated with safety systems. A definite need was found for specification of the functional requirements for LPMS, in the form of a clear and comprehensive statement of NRC policy regarding the formulation and implementation of safety-oriented, yet operationally practicable, loose-parts monitoring programs for both existing and future nuclear generating stations so that overall objectives of both the utilities and the regulatory agency might be satisfied simultaneously.

10096 (NEDO—21061(Rev.2)) **Supplement 1 to amendment 2 to Mark II containment dynamic forcing functions information report, NEDO/NEDE 21061.** (General Electric Co., San Jose, Calif. (USA). BWR Projects Dept.). Aug 1977. 48p. Electric Company, San Jose, CA.

Requested information is presented concerning the pressure gradients and stresses related to the Mark II containment.

10097 (OCF—1) **Detailed safety analysis of Owens—Corning fiberglas nuclear containment insulation system: NU'K'ON.** (Owens-Corning Fiberglas Corp., Lenexa, Kans. (USA). Power and Process Contracting Services Div.). Aug 1977. vp. Fiberglas Corp., Lenexa, KS.

Owens-Corning Fiberglas' Nuclear Containment Insulation System (Nu'K'on) is a thermal insulation system designed for nuclear piping and equipment. It is shown that the Nu'K'on system will not cause the malfunction of any component or lead to a health hazard during normal operations; and, will not retard the operation of any emergency system or complicate the effects of an accident when used in light water nuclear power plants. The report includes a listing of both normal and accident design conditions; a complete potential problem analysis for insulation in general; description and analysis of the specific testing program used; a listing of all results and conclusions; and recommendations for the general evaluations of insulation systems for safety performance.

10098 (ORNL/NUREG—4) **Stresses in reinforced nozzle-cylinder attachments under internal pressure loading analyzed by the finite-element method: a parameter study.** Bryson, J.W.; Johnson, W.G.; Bass, B.R. (Oak Ridge National Lab., Tenn. (USA)). 6 Sep 1977. Contract W-7405-ENG-26. 213p. Dep. NTIS, PC A10/MF A01.

A parameter study was conducted on stresses in reinforced nozzle-to-cylinder attachments under internal pressure loading as analyzed by the finite-element method. Twenty-five models with branch-to-run diameter ratios 0.08 less than or equal to d/D less than or equal to 0.50 and run diameter-to-thickness ratios 10 less than or equal to D/T less than or equal to 100 were investigated. A three-dimensional finite-element program, CORTES-SA, which was developed at the University of California at Berkeley specifically for analyzing tee-joint configurations, was used in the study. It was concluded from the study that both of the reinforcement designs investigated significantly reduce maximum stresses relative to configurations having little or no reinforcement. For internal pressure loading, neither of the reinforcement designs offered a significant advantage over the other in that both types of reinforcement gave very nearly the same maximum stresses.

10099 (Y/OWI/SUB—77/45200) **US LWR spent fuel inventory and protection.** Woodhall, C.B. (Nuclear Assurance Corp., Atlanta, Ga. (USA)). Jun 1977. Contract W-7405-ENG-26. 205p. Dep. NTIS, PC A10/MF A01.

Information concerning discharged fuel characteristics for every US light water reactor (LWR) expected to operate and discharge fuel through 1986 is presented. These characteristics include: (1) the date, number of assemblies, and weight (Metric Tons of Heavy Metal-MTHM) of each projected discharge; (2) the batch average burnup, U_{235} enrichment, total plutonium, and percent fissile plutonium for each projected discharge; and (3) the expected location of the discharged fuel.

10100 Support grid for fuel elements in a nuclear reactor. Finch, L.M. (to Energy Research and Development Administration). US Patent 4,028,180. 7 Jun 1977. Filed date 16 Mar 1976. 6p.

PAT-APPL-667,815.

A support grid is provided for holding nuclear fuel rods in a rectangular array. Intersecting sheet metal strips are interconnected using opposing slots in the strips to form a rectangular cellular grid structure for engaging the sides of a multiplicity of fuel rods. Spring and dimple supports for engaging fuel and guide rods extending through each cell in the support grid are formed in the metal strips with the springs thus formed being characterized by nonlinear spring rates.

10101 How ISI experience impacts on design and operation. Lautzenheiser, C.E.; Whiting, A.R. (Southwest Research Inst., San Antonio, Tex. (USA)). *Nucl. Eng. Int.;* **22**: No. 258, 62-64(Jun 1977).

Experience of the Southwest Research Institute in in-service examination of heavy-walled pressure vessels is described. The type of equipment and method of examination dictate the access required. Designing for access is discussed in relation to PWR and BWR reactors. Training of personnel is discussed. Some of the problems to be overcome such as comparison of inspection performance by different agencies, the variability of inspection equipment, and difficulties associated with inspection of welded joints, are described.

10102 Water chemistry in Swedish BWR reactors - operational experience. Fejes, P. (ASEA-ATOM AB, Vaesteraas (Sweden)). *VGB Kraftwerkstech.;* **57**: No. 2, 112-116(Feb 1977). (In German).

Due to the high demands made on the purity of water (i.e. electric conductivity near the theoretical values) in containment and feedwater system, the layout of the cleaning system and choice of processes are of high importance. Using the example of the Oskarshamn 1 BWR, which has more than 100 sampling points for the best possible monitoring of plant functions, the positive influence of a neutral mode of operation and of the condensate purification process described here - using filters precoated with ion exchanger material - on the release of corrosion products into the coolant is shown. The results are so good that mechanical filtration of the reactor water can be dispensed with in all Swedish BWR reactors.

10103 Construction features of the Caorso nuclear power station Mark 2 primary containment. Crucitti, N. (Ansaldo S.p.A., Genoa (Italy)). *Energ. Nucl. (Milan);* **24**: No. 3, 123-138(1977).

This article describes the main construction features of the Mark 2 primary containment of the Italian ENEL-4 Caorso nuclear power station (BWR General Electric, 840 MWe). The Main contractor of the whole station has been AMN Impianti Termici e Nucleari (Genova, Italy).

10104 Amount of slurries presenting itself during the conditioning of coolants in nuclear power plants and its treatment. Andres, O.; Ortner, G. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G., Essen (Germany, F.R.). Abt. Kraftwerke); Pauls, B. (Kutsch (K.) G.m.b.H., Dueren (Germany, F.R.)). *Energie;* **28**: No. 12, 353-356(Dec 1976). (In German).

The dehydration rate is determined by the dehydration method chosen and by the composition of the solid matter in the wet sludge. The method itself is selected by taking into account the given facts for dumping and the various possibilities of reusing the calcium carbonates. Even bigger amounts of sludge cakes, and higher transport and tipping costs in connection with these, can be put up with.

10105 Fuel assembly of 8 x 8 type used for BWRs. *Genshiryoku Iinkai Geppo;* **21**: No. 7, 43-46(Oct 1976). (In Japanese).

The purposes of this examination are to investigate the basic design and to evaluate the safety of the fuel assembly of 8 x 8 type for BWRs designed by General Electric Corp. The range of the examination extended over the structural strength design and the nuclear-thermal design of the fuel assembly. The evaluation of the specific core or reactor charged with the fuel assembly of 8 x 8 type shall be carried out at the time of the respective safety deliberation. BWR New Fuel Examination Committee established in May 1974 held ten meetings, and has come to the conclusion. In this fuel assembly, the fuel rods consisting of the cladding tubes made of Zircaloy 2, containing low enriched uranium dioxide pellets, are held in the lattice arrangement of 8 lines and 8 rows with spacers,

and the square channel box is fixed outside. The main points of change are the lattice arrangement and the reduction of fuel rod diameter. The points of the examination are the failure limit according to plastic strain and critical heat flux ratio, the stress imposed on cladding tubes, accumulated fatigue cycles, the stability of dimensions and shape, the hydrogen embrittlement of Zircaloy, fretting corrosion, the collapse of cladding tubes, the interaction between pellets and claddings, the reactivity factor and so on. No abnormality has been reported so far regarding the fuel assembly of 8 x 8 type in actual service, therefore there is no problem in the use of the fuel assembly of 8 x 8 type.

10106 Burn-up of light water reactor fuels. Natsume, H. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Proc. Jpn. Conf. Radioisot.;* No. 12, 293-302(Jun 1976). (In Japanese).

From 12. Japan conference on radioisotopes; Tokyo, Japan (26 Nov 1975).

The research on the measurement of nuclear fuel burn-up in Japan Atomic Energy Research Institute is oriented to the improvement of economy of power reactors, the technical development of fuel management and fuel development. The burn-up measurement carried out for JPDR (a boiling water reactor with 45 MW heat output, and fueled with 2.6% enriched UO_2) in JAERI by nondestructive gamma spectrometry and destructive chemical analysis is described. Then, the works made on the isotopic correlation technique are explained. For the gamma spectrometry, the gamma scanning apparatus in the fuel storage pool for the JPDR was used; for the chemical analysis, the solution of fuel was taken with a chemical balance. The isotopic correlation technique was performed for fission products and heavy elements.

10107 Fuel assembly. Yamashita, J.; Shimoshige, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-148194/A/. 16 Jun 1975. 4p. (In Japanese).

A means is provided to divide fuel rods into several blocks so that fuels may be reversed vertically every block to leave sufficient allowance for reactor stoppage, thus enhancing taking-out combustion quality. A fuel inserting portion in upper and lower tie plates is designed so that a vertically symmetrical fuel may be inserted. That is, the construction of the fuel rod itself is entirely vertically symmetrical. Fuel regions are symmetrically arranged on uppper and lower ends, and expansion springs are also inserted at upper and lower parts. Outer springs of the fuel rods are always retained at plug portions on upper and lower ends. The fuel rods are of the subchannel construction consisting of several rods, the fuel rods being separable from one another every sub-channel. Accordingly, the fuel may be reversed every sub-channel.

10108 Fuel element. Iwano, Y.; Une, K. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-148193/A/. 13 Jun 1975. 3p. (In Japanese).

A in hydrogen getter charged into a clad pipe element is coated with a hydrogen permeating material to thereby prevent the gettering material from formation of oxide film, thus always maintaining hydrogen reactivity. Hydrogen mixed into the clad pipe closed by an end plug or hydrogen generated from water content deposited on walls in the clad pipe permeates the hydrogen permeating material to come into reaction with the gettering material or to be absorbed for removal.

10109 Reactor structure. Naito, M.; Chino, K.; Uchida, S. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-144893/A/. 9 Jun 1975. 5p. (In Japanese).

In a boiling water reactor having a plurality of coolant recirculating systems, a partitioning plate is disposed in a space between the shroud and the vessel so as to define the recirculating systems, thereby retaining temperature of the fuel clad pipe in a low level when trouble of coolant loss occurs, to prevent breakage of the clad pipe.

10110 Fuel assembly. Sugisaki, T.; Horiuchi, T.; Ogasawara, H.; Yamanari, S.; Tominaga, K. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-140090/A/. 30 May 1975. 6p. (In Japanese).

Disclosed is a means to prevent failure of fuel rods resulting from trouble of coolant loss without modification of basical construction of a cooling device in a low pressure water injection system. An opening is provided having a sectional area which is 10 to 20% of that of a cooling water passage, at a position lower than an upper tie plate on the wall surface of a channel box enclosing therein fuel rods but at a position higher than an effectively heat-generating upper end of the fuel rods. With this arrangement, flow of spray water into the fuel assembly and resultant impeding phenomenon or the like can be avoided.

10111 Method for limiting scram discharge water. Nagata, K. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-137091/A/. 23 May 1975. 3p. (In Japanese).

A system to limit the amount of discharge water in a primary system at the time of scram to prevent excessive outflow of reactor water outside the systemis disclosed. A signal from an upper limit position indicator detects the fact that control rods are completely inserted when the reactor is urgently stopped and the detection signal causes a valve in an outflow line of the discharge water from a control rod driving mechanism to be closed to limit the amount of discharge into the scram discharge vessel, thus preventing outflow of reactor water in the primary system after the scram has been initiated.

10112 Nuclear fuel assembly. Matsumoto, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-136094/A/. 19 May 1975. 3p. (In Japanese).

To provide a fuel assembly used in a boiling water reactor which is designed to increase cooling efficiency at the time of core spray cooling, a stand-pipe is mounted partly in a coolant passage opened in an upper tie plate to which fuel rods are secured. At the time of core spray, the core spray water drops into a channel box through holes in the upper tie plate and at the same time, vapor generated inside of the channel box goes upwardly passing through the stand-pipe to prevent the core spray water from being come into contact with the rising vapor.

10113 Automatically remote-controlled auxiliary device. Ito, Y.; Hattori, N.; Sakurai, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-133687/A/. 16 May 1975. 4p. (In Japanese).

A device to accomplish the operation of a fuel replacing truck on the reactor well and fuel storage pool with automatic remote control of high reliability is disclosed. A template model, in which an actual maximal working range of a fuel gripper in a fuel replacing truck used to transport fuel within the reactor and fuel pool is simulated in a suitable reduced scale, is interiorly provided with a limit switch to project movement of the gripper in the same reduced scale, whereby when the fuel gripper tends to impinge upon the pool wall as a result of displacement thereof from a proper working range, the limit switch is actuated to thereby stop movement of the truck, thus preventing occurrence of trouble.

10114 Seal structure of diaphragm floor in a reactor container. Yoshinaga, T.; Yamamoto, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-133685/A/. 16 May 1975. 3p. (In Japanese).

Disclosed s a means to easily and economically install and maintain a diaphragm floor seal portion to increase safety of the reactor container. In the seal structure of diaphragm floor, which serves to isolate the dry well portion from the suppression chamber portion in the reactor container, there are provided with a concave groove formed in the vicinity of the dry well in the peripheral edge portion of the diaphragm floor and a metallic bellows of U-shape in section formed with a convex surface in engagement with said concave groove and joined to the dry well and the diaphragm floor, whereby when excessive internal pressure is produced as a result of piping rupture within the dry well, the metallic bellows comes into close contact within the concave groove to prevent excessive formation by the back-up thereof, thus avoiding breakage.

10115 Containment spray system. Uchida, S. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-132396/A/. 14 May 1975. 4p. (In Japanese).

A water-circulation spray system is attached to a container in order to be actuated at the time of failure of a light-water nuclear reactor, which can remove iodine from the container effectively and under the stabilized operation for a long period of time without need of mixing chemical matter to spraying water. On the downstream of a residual heat exchanger mounted in the spray system there is provided a purifier as the means for removing iodine from a part of circulating water. This purifier is disposed in bypass which is formed by opening the valve, and water passed through the bypass is returned to the spray system.

10116 Internal component element for a reactor. Tsuji, T.; Futatsugi, M.; Itoi, H.; Imoto, K. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-126496/A/. 28 Apr 1975. 4p. (In Japanese).

Disclosed is a means to protect a neutron detector assembly and a fuel assembly from wear and damage by suppressing vibration of the neutron detector assembly by means of a vibration prevention means mounted on the outer periphery of the neutron detector assembly. A frictional type vibration prevention means made of a metal softer than that of the channel box of a fuel assembly is mounted on the outer periphery of the neutron detector assembly such that it is partly in contact with the channel box. With this arrangement, vibrations produced by the flow of reactor water or earthquakes are suppressed by the vibration prevention means and not transmitted to the neutron detector.

10117 Boiling commencement detecting means for reactor. Izumi, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-121691/A/. 18 Apr 1975. 2p. (In Japanese).

The point at which boiling begins is detected by measuring void distribution from neutron flux with a simple means by making use of the idle time of a device for measuring neutron flux in the direction of the reactor axis. A detector for detecting neutrons within a transportable reactor is inserted from the lower portion of the core, and as it is lowered from the upper portion the neutron flux as the output of a neutron flux calculator is recorded in an X-Y recorder. The output of the neutron flux calculator is coupled to a band-pass filter, which extracts components due to the void influence. Then, the void distribution in the axial direction is derived by using a squarer and an integrator. At this time, the void distribution can be recorded in the X-Y recorder by connecting a selection switch to the side of void extent measurement. The point at which boiling commences is one at which the value of the void distribution recorded in the X-Y recorder suddenly increases.

10118 Water supply control means for a boiling water reactor. Omori, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-111595/A/. 26 Mar 1975. 5p. (In Japanese).

A means is disclosed to enhance response character at the time of rendering the reactor water level constant by adding a speed difference signal from a recirculation speed control system and an output signal from a preset pressure adjuster as input signals to a three-element control system. A water supply control system is constructed such that five different inputs, namely the water level of reactor, rate of vapor flow, rate of water supply, deviation of recirculating pump speed and output of a preset pressure adjuster, are used as control input signals for carrying out linear and integral operations in a water supply controller, the output of which is used to control the water supply control valve. By imparting the system with a feed forward function it is possible to obtain excellent response characteristics in both manual and automatic load follow controls irrespective of use or non-use of the preset pressure adjuster.

10119 Lower tie plate of fuel assembly. Nakamura, S.; Ozawa, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-110192/A/. 24 Mar 1975. 4p. (In Japanese).

Disclosed is a system to prevent leakage of a cooling medium through reduction of the difference between the inner and outer pressures on the lower portion of a channel box by providing a nozzle section at a cooling medium outlet of a lower tie plate. A cooling medium passage where a fuel rod end plug of a lower tie plate is secured is made in the form of a nozzle. In this way, a portion of the dynamic pressure of the total pressure of the cooling medium is increased to reduce the static pressure portion so as to reduce the difference between the inner and outer pressures on the lower portion of a channel box lower for preventing the leakage of the cooling medium.

10120 Iodine removing means. Takeshima, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-110199/A/. 24 Mar 1975. 4p. (In Japanese).

Disclosed is a means to employ exhaust gas from an incinerator to effect regeneration of an adsorbent such as active carbon which has adsorbed a radioactive gas such as iodine contained in the ventilating system exhaust gas of a boiling water reactor power plant. Radioactive exhaust gas such as iodine, xenon and krypton is led to an active carbon adsorbing means for removal through adsorption. When the adsorbing function of the active carbon adsorption means is reduced, the exhaust gas discharged from the incinerator is cooled down to 300°C and then caused to flow into the active carbon layer, and after depriving it of sulfur dioxide gas, oxides of nitrogen, daughter nuclides resulting from attenuation of radioactive gas and so forth, these being adsorbed by the carbon active layer, it is led again to the incinerator, whereby the radioactivity accompanying the regenerated gas is sealed as ash within the incinerator. Further, similarly accompanying fine active carbon particles and the like are utilized as a heat source for the incinerator.

10121 Method of installing a reactor container. Hayashi, K.; Murakawa, H. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-102797/A/. 7 Mar 1975. 2p. (In Japanese).

To achieve exact installation of a reactor container at a site a pole is set upright at the center of a cylindrical base portion, a plurality of beams are disposed around the pole in a radial fashion to form a cone, a plurality of steel plates are mounted successively around the cone through a ring, and the steel plates are welded to each other to assemble and install a reactor container at the same time.

10122 Aseismic buffer means for a reactor pressure vessel. Hayashi, E. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-101690/A/. 5 Mar 1975. 4p. (In Japanese).

An aseismic buffer means is provided between a pressure vessel and gamma radiation shield in a boiling water reactor whih consists of a structure with the capability of applying to a dish spring within the factory. An initial clamping load predetermined in view of aseismic considerations. A box-like distance block is provided between two pairs of dish springs. Within the factory, a rod is passed through a hole in this distance block so as to clamp the distance block from the opposite sides by washers, dish springs and stoppers. The aseismic buffer means is then assembled by applying to the dish spring the initial clamping load determined according to aseismic considerations. Thereafter, the distance block is secured at the site to a stabilizer bracket secured by welding to the reactor pressure vessel installed within the reactor container by means of bolts and nuts, and then the bracket is secured by welding to the gamma radiation shield.

10123 Notes on the welding of the internal structure of a pressure vessel for a boiling water reactor. Cattini, U.; Peloso, G.P. *Riv. Ital. Saldatura;* **27**: No. 6, 374-376(1975). (In Italian).

The internal construction of the nuclear reactor consisting of arrays of vertical tubes 276 and 170 mm in dia. welded into top and bottom support plates is described. The material was austenitic stainless steel. Components were cut with a plasma torch and welding techniques used for different sections included manual arc with coated electrodes, manual TIG, and automatic submerged arc. Welding and control procedures are described.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 10095, 10097, 10098, 10099, 10100, 10101, 10104, 10106, 10108, 10115, 10116, 10263, 10264, 10266, 10267, 10370, 10374, 10375, 10376, 10380, 10387, 10433, 10434, 10435, 10443, 10445, 10466, 10467, 10471, 10492

10124 (EPRI-NP—296) **Scaled thermal hydraulic simulation of open lattice PWR cores: a scoping study. Final report, Task B.** Sreepada, S.; McAssey, E. Jr.; Casterline, J.; Borak, F. (Columbia Univ., New York (USA). Dept. of Chemical Engineering). Apr 1977. 153p. Dep. NTIS, PC A08/MF A01.

A detailed analytical investigation of the feasibility of simulating large open lattice pressurized water reactor cores using 400 to 500 electrically heated pins was conducted. Within the constraints of a 12 MW power system, three types of simulations can be carried out: (1) A two bundle reactor size assembly simulation to provide data to substantiate analytical models; (2) A ⅓ scale simulation of 1200 to 1500 rods with both axial and transverse directions scaled by the same factor; this would provide an undistorted geometrical scaling, satisfying all similarity criteria; and (3) A regional simulation of considerably more than six reactor assembly regions accomplished by a distorted geometrically scaled model satisfying simulation criteria. In such a model equal scaling will be used in both axial and transverse directions. This is true for all dimensions except rod diameter and pitch, which may be sized by a different scale factor. To satisfy the simulation criteria, the number of pins per model assembly will be less than the number of pins per prototype assembly. Based on the requirements of such a simulation, the adequacy of the existing facilities at the Heat Transfer Research Facility of Columbia University was evaluated. The requirements for a loop in which such tests can be performed are defined.

10125 Guide device. Brammer, C.M. Jr. (to Westinghouse Electric Corp.). US Patent 4,053,356. 11 Oct 1977. Filed date 8 Aug 1975. 6p.

Disclosed is a fuel handling guide tube centering device for use in nuclear reactors during fuel assembly handling operations. The device comprises an outer ring secured to the flange of a nuclear reactor pressure vessel, a rotatable table rotatably coupled to the outer ring, and a plurality of openings through the table. Truncated locating cones are positioned in each of the openings in the table, and the locating cones center the guide tube during fuel handling operations. The openings in the table are located such that each fuel assembly in the nuclear core may be aligned with one of the openings by a suitable rotation of the table. The locating cones thereby provide alignment between the fuel handling mechanism located in the guide tube and the individual fuel assemblies of the cone. The need for a device to provide alignment is especially critical for floating nuclear power plants, where wave motion may exist during fuel handling operations. 5 claims, 4 figures.

10126 Air box shock absorber for a nuclear reactor. Pradhan, A.V.; George, J.A. (to Westinghouse Electric Corp.). US Patent 4,053,357. 11 Oct 1977. Filed date 3 Dec 1975. 10p.

Disclosed is an air box type shock absorber primarily for use in an ice condenser compartment of a nuclear reactor. The shock absorber includes a back plate member and sheet metal top, bottom, and front members. The front member is prefolded, and controlled clearances are provided among the members for predetermined escape of air under impact and compression. Prefolded internal sheet metal stiffeners also absorb a portion of the kinetic energy imparted

to the shock absorber, and limit rebound. An external restraining rod guided by restraining straps insures that the sheet metal front member compresses inward upon impact. 6 claims, 11 figures.

10127 Pressurized-water reactor emergency core cooling system. Winkler, F.; Heif, H. (to Kraftwerk Union AG). US Patent 4,046,626. 6 Sep 1977. Priority date 20 Nov 1973, German, Federal Republic of (F.R. Germany). 4p.

An emergency core cooling system for a pressurized-water reactor provides one supply of emergency water under pressure for injecting into the reactor's pressure vessel's lower plenum through a check valve, and a separate supply of emergency water under pressure for injecting into the vessel's upper plenum through a second check valve, the pressure on both supplies of emergency water being lower than the pressure of the reactor's coolant under normal reactor operating conditions. Because each plenum is separately supplied with emergency water when required, the pressures and flow rates can be designed for core cooling efficiency in the event of an accident. 2 claims, 2 figures.

10128 Reactor fuel assembly lock transport. Schabert, H.P.; Poerner, H.; Bauter, A. (to Kraftwerk Union AG). US Patent 4,044,898. 30 Aug 1977. Priority date 16 Jul 1974, German, Federal Republic of (F.R. Germany). 4p.

To transport fuel assemblies through a lock leading into a reactor containment, reciprocatory rods are used which releasably engage a sliding carriage carrying the fuel assemblies, at longitudinally interspaced points. This eliminates special transport equipment in the vicinity of the lock. The invention is of interest particularly for pressurized-water reactor installations. 6 claims, 2 figures.

10129 Steel-concrete combination element for lining vessels such as storage tanks, prestressed concrete reactor pressure vessels, and the like. Sturmer, H.; Schweim, K. (to L. and C. Steinmuller GmbH). US Patent 4,044,522. 30 Aug 1977. Priority date 24 Jul 1974, German, Federal Republic of (F.R. Germany). 2p.

Compound elements are disclosed for lining such vessels as storage tanks, prestressed concrete reactor pressure vessels, and other gastight areas for use in nuclear reactor construction. The compound elements have a leakproof, plate-shaped metal base, and comprise anchors, contact elements, and reinforced concrete. The contact elements and base of one compound element are welded to a contact element and the base of an adjacent combination element so as to confine with each other a hollow chamber. 1 claim, 3 figures.

10130 Rack for nuclear fuel elements. Rubinstein, H.J.; Gordon, C.B.; Robison, A.; Clark, P.M. (to Nuclear Services Corp.). US Patent 4,042,828. 16 Aug 1977. Filed date 17 Nov 1975. 12p.

Disclosed is a rack for storing spent nuclear fuel elements in which a plurality of aligned rows of upright enclosures of generally square cross-sectional areas contain vertically disposed spent fuel elements. Each fuel element is supported at the lower end thereof by a respective support that rests on the floor of the spent fuel pool for a nuclear power plant. An open rack frame is employed as an upright support for the enclosures containing the spent fuel elements. Legs at the lower corners of the frame rest on the floor of the pool to support the frame. In one exemplary embodiment, the support for the fuel element is in the form of a base on which a fuel element rests and the base is supported by legs. In another exemplary embodiment, each fuel element is supported on the pool floor by a self-adjusting support in the form of a base on which a fuel element rests and the base rests on a ball or swivel joint for self-alignment. The lower four corners of the frame are supported by legs adjustable in height for leveling the frame. Each adjustable frame leg is in the form of a base resting on the pool floor and the base supports a threaded post. The threaded post adjustably engages a threaded column on which rests the lower end of the frame. 16 claims, 14 figures.

10131 Secondary system modeling and method for a nuclear power plant training simulator. Johnson, S.J. (to Westinghouse Electric Corporation). US Patent 4,042,813. 16 Aug 1977. Filed date 31 Oct 1974. 52p.

Disclosed is a method and system for the real-time simulation of the dynamic operation of a nuclear power plant in which a secondary system for operating the steam turbine includes reheaters for increasing the steam temperature and pressure between the low and high pressure turbine stages, an electrohydraulic controller for operating the turbine at required speed, a condenser for condensing turbine exhaust steam, a condensate and feedwater system for pumping condensed steam back to the secondary side of a steam generator, a gland steam system for preventing leakage from and to the atmosphere, and a cooling system for the main generator, utilizes apparatus that includes a digital computer for calculating output data corresponding to physical values for the operation of the plant in accordance with input data. A control console includes automatic and manually operable devices corresponding to plant control devices for varying the input data, and indicating devices responsive to the output data for monitoring the operation of the plant. 40 claims, 45 figures.

10132 Study of primary circuit transfer functions of PWR nuclear power stations. Benedek, S. (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). *Kernenergie;* **20**: No. 8, 238-241(Aug 1977).

The purpose of the present study is to examine the effect exerted by parameters in change during operation on the forms of the transfer functions. According to the examination, the forms of the transfer functions are changing only in function of the burnup conditions of the fuel. When the heat transfer coefficient (in the fuel rod or in the secondary side of the steam generator) and the axial heat distribution in the fuel rod are changed, the transfer functions do not change.

10133 Rhodium self-powered detector signal as a function of the neutron spectrum in WWER type reactors. Kubowski, J. (Institute of Nuclear Research, Warsaw (Poland)). *Kernenergie;* **20**: No. 8, 255-259(Aug 1977). (In German).

Calculated results are presented of the output current variation for rhodium self-powered detector in a WWER-type reactor depending on emitter burnup, boron concentration in the coolant, fuel burnup, and fuel enrichment. The multigroup programme LASER was applied to calculate the lattice-cell parameters and the neutron spectrum. The detector current has been calculated considering the prompt component on the basis of a 30-group set of constants for the Compton effect and the photoeffect.

10134 Rationalizing of construction engineering of nuclear power plants with pressurized water reactors. Schmidt, S. (Bauakademie der DDR, Berlin. Inst. fuer Industriebau). *Kernenergie;* **20**: No. 8, 249-252(Aug 1977). (In German).

From 7. meeting on power plant engineering; Dresden, German Democratic Republic (30 Sep 1975).

Construction of large power plants requires further reduction of construction efforts and the construction period. A new constructional and technological solution has been developed with the steel-cell composite structure applied in the Greifswald nuclear power plant 'Bruno Leuschner' for the first time. Principles of design, fabrication, transport, and mounting are described. The benefits of the method are indicated.

10135 Gamma spectrometric determination of burnup distribution in a fuel assembly from the Rheinsberg nuclear power plant. Mehner, H.C.; Graber, H.; Hofmann, G.; Nagel, S. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)); Guenther, H. (VEB Kernkraftwerk Bruno Leuschner, Greifswald (German Democratic Republic). Betriebsteil Kernkraftwerk Rheinsberg). *Kernenergie;* **20**: No. 8, 242-246(Aug 1977). (In German).

Burnup distribution over the cross section of a fuel assembly from the Rheinsberg nuclear power plant has been determined by gamma spectrometry of fuel rods. The results obtained from selected fuel rods have been used as the nodes in a two-dimensional interpolation programme that calculates the burnup distribution by fitting the given function to the values measured. It is assumed that burnup distribution is described by a fraction characteristics for the type of fuel assembly and another fraction due to the effect of macroburnup. Uncertainty of the burnup distribution thus determined amounts to +- 3.1%. The results are compared with those obtained theoretically.

10136 Natural circulation in the WWER 440 reactor. Alpatov, A.M.; Gutsalov, A.T. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). *Kernenergie;* **20**: No. 7, 217-219(Jul 1977). (In German).

From 2. CMEA seminar 'Exchange of experience in construction and operation of nuclear power plants with .WWER type reactors'; Neuglobsow/Rheinsberg, German Democratic Republic (23 - 26 Mar 1976).

The results of some studies on natural circulation of the coolant in WWER 440 reactors are given. The thermodynamic and hydrodynamic characteristics of the primary coolant circuit with natural circulation obtained during start-up of Soviet and other nuclear power plants are presented. On the basis of experimental data the limit power which can be taken from the core has been determined as a function of the loops being in operation.

10137 Experiences in the construction of WWER reactors in the USSR. Denisov, V.P.; Stekol'nikov, V.V.; Biryukov, G.I.; Vichorev, Yu.V. (Versuchskonstruktionsbuero 'Hydropress' (USSR)). *Kernenergie;* **20**: No. 7, 197-206(Jul 1977). (In German).

From 2. CMEA seminar 'Exchange of experience in construction and operation of nuclear power plants with WWER type reactors'; Neuglobsow/Rheinsberg, German Democratic Republic (23 - 26 Mar 1976).

Extensive scientific research and planning as well as industrial control of a number of intricate thermodynamic problems in designing the basic equipment of WWER type reactors have led to technical solutions assuring long-term operating stability and high technical and economic performance of the nuclear power plants. The serially produced WWER reactor with 440 MW is based on

improvements of the first reactors of this type, WWER-1 and WWER-3M. Thus, operating reliability could be increased and a technology adequate to the production of equipment allowing on-line control of individual systems could be established. On the basis of experiences gained from the construction of reactors of the first generation the modern WWER type reactor with 1,000 MW was developed. A comparison shows that WWER type reactors fully correspond with other modern pressurized water reactors of approximately the same power considering physical and thermodynamic characteristics as well as the design. In constructing WWER type reactors in the USSR and pressurized water reactors in other countries extensive experiences have been gained and appropriate solutions of engineering problems have been found, the most important of which are the 1) determination of optimum physical, thermodynamic and hydrodynamic characteristics of the core; 2) foundation of structural stability and longevity of the reactor and the primary circuit equipment; 3) choice of structural materials for the reactor and the primary circuit.

10138 Computational methods for burnup determination in WWER type reactors of the Novo Voronezh nuclear power plant. Golubev, L.I.; Tsybenko, V.M. (Kernkraftwerk Novo-Voronesh (USSR)). *Kernenergie;* **20**: No. 7, 206-213(Jul 1977). (In German).

From 2. CMEA seminar 'Exchange of experience in construction and operation of nuclear power plants with WWER type reactors'; Neuglobsow/Rheinsberg, German Democratic Republic (23 - 26 Mar 1976).

The method for determining the fuel load of the Novo Voronezh power reactors is described. Accuracies obtained in calculating the duration of reactor campaigns and the fuel burnup are analyzed in detail on the basis of experimental data. The results obtained with the aid of computer codes are estimated to be sufficiently precise for the purposes of reactor operation.

10139 Measurements of fuel assembly power by means of temperature detectors. Mitin, V.I.; Tsimbalov, S.A.; Alikin, E.D. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). *Kernenergie;* **20**: No. 7, 213-216(Jul 1977). (In German).

From 2. CMEA seminar 'Exchange of experience in construction and operation of nuclear power plants with WWER type reactors'; Neuglobsow/Rheinsberg, German Democratic Republic (23 - 26 Mar 1976).

Fuel assembly power in WWER type reactors is controlled by temperature measurements using thermocouples. Formulas are given for determination of the assembly powers from measured temperature values. The errors resulting from the temperature measurements are analyzed and distinguished into a constant, a rapidly varying, and a slowly varying component. Those components are determined in detail. The operative quality control of the temperature control systems in WWER type reactors may be achieved as both wrong signals from the thermocouples and defective thermocouples themselves can clearly be identified. The results have been verified by appropriate measurements in the first and second unit of the Kola nuclear power plant.

10140 Method for calculating the dynamic characteristics of the steam volume compensator in nuclear power plants equipped with WWER type reactors. Poletaev, G.N.; Sulchanishvili, N.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). *Kernenergie;* **20**: No. 7, 219-224(Jul 1977). (In German).

From 2. CMEA seminar 'Exchange of experience in construction and operation of nuclear power plants with WWER type reactors'; Neuglobsow/Rheinsberg, German Democratic Republic (23 - 26 Mar 1976).

A method for calculating the dynamic characteristics of the steam volume compensator provided for WWER type reactors is described. This method takes into account the operation of the automatic system including electrical heaters, valves for injection of the cold coolant into the steam compartment of the compensator, and the valves for steam release. A computer code in FORTRAN-CERN has been established and realized for the BESM-6 computer on the basis of the proposed method. The results of calculations are presented and compared with experimental data.

10141 Pressurised water may be best for long term. Butler, P. *Engineer;* **244**: No. 6325, 38-39(18 Jun 1977).

With the choice of reactor for Britain still undecided, many of the points used in arguments for and against adoption of the AGR, as an alternative to a PWR system are put forward. The main considerations for both types of reactor and also for the SGHWR, covering cost, safety, and marketing prospects are compared.

10142 Escom joins the nuclear age. Russel-Walling, E. *M.A.N. (Maschinenfabr. Augsb.-Nuernb.) Forsch., Planen, Bauen;* 40-60(Apr 1977).

Almost 300 years after their first appearance at the Cape, the French are returning there. This time, however, it is not to introduce wine to South Africa but nuclear power. Duynefontein, just north of Cape Town on a stretch of windswept coast has been chosen for SA's first nuclear power station, to be constructed at an estimated cost of more than R1-billion. The author examines what nuclear power will mean to SA and why its introduction was delayed until now.

10143 Transient processes in PWR fuel element. Juzova, Z.; Kostalek, J. *Jad. Energ.;* **22**: No. 9, 350-355(Sep 1976). (In Czech).

From Nonstationary and accident states of pressurized-water reactor power plants; Plzen, Czechoslovakia (11 - 13 May 1976).

The programmes are described for the calculation of thermal and hydraulic behaviour of individual fuel clusters of the reactor core in steady-state and transient processes which may occur in case of a possible accident. The computation programme COBRA-III copes with a detailed subchannel analysis of the fuel element, this both for the stationary and transient states. The basic idea is the fictitious division of the channel formed by a rod cluster into parallel subchannels. Mass, energy and momentum transport occurs between neighbouring subchannels, this owing to turbulent mixing and to transversal flow caused by pressure differences. Heat transfer by conduction may also be considered. Programme TRANS calculates non-stationary processes in the fuel element, not considering detailed subchannel analysis of the cluster but considering the concentrated parameters of coolant along the element cross-section, i.e., the one-dimensional flow of coolant through the cluster (perfect mixing) and a homogeneous distribution of heat sources through the transverse cross-section.

10144 Ten years' experience of the Novovoronezh nuclear power plant in work organization and control. Jech, V.; Karas, P. (Ceske Energeticke Zavody, Generalni Reditelstvi, Prague (Czechoslovakia)); Rozinek, P. (Vyskumny Ustav Energeticky, Jaslovske Bohunice (Czechoslovakia)). *Jad. Energ.;* **22**: No. 9, 322-327(Sep 1976). (In Czech).

The history of the construction and operation of the Novovoronezh nuclear power plant in the years 1964 to 1974 is briefly described. The organization and management of work and maintenance, the training of personnel and the training of technicians are described. The rationalization of personnel numbers could be carried out on the basis of operating experience, analyses of qualification requirements, working schedules and working regulations.

10145 17 x 17 type fuel assembly for PWR. *Genshiryoku Iinkai Geppo;* **21**: No. 6, 29-33(Aug 1976). (In Japanese).

The 17 x 17 type fuel assembly designed for PWRs by Westinghouse, U.S., has been examined by the reactor safety study committee of the Japan AEC. The fuel rods consist of slightly enriched UO_2 pellets in Zircalloy-4 claddings. The fuel assembly was confirmed to be without problem when used for PWRs. The results of the following investigations are described: structural design, nuclear design, thermo-hydraulic design, etc.

10146 Analysis of dynamic characteristics of Genkai No.1 plant. Tokubuchi, T.; Nakamura, M.; Matsushita, K.; Isobe, S. (Kyushu Electric Power Co., Inc., Fukuoka (Japan). Research Dept.). *Kernenergie;* **45**: 159-169(Mar 1976). (In Japanese).

In order to determine the dynamic characteristics of the whole system comprising the nuclear steam generation installation and the nuclear reactor-controlling system, the preliminary analysis was carried out by Mitsubishi Atomic Power Industries and Kyushu Electric Power Co., and on the basis of this analysis model, the detailed analysis was carried out by MAPI. In this paper, the formulation of the analysis model for the preliminary analysis, the construction of the analog computer circuit, and the comparison of the power output test results for Genkai No.1 plant with the detailed analysis results are reported. In the Genkai No.1 plant, the control systems for the nuclear steam generation installation and the turbo-generator installation are set up independently, and the nuclear reactor is so controlled as to follow the load variation of the turbo-generator. The reactor-controlling system comprises the systems for controlling the control rods, the pressure and water level in the pressurizer, the water level in the steam generator, and the turbine by-pass. The analysis of the dynamic characteristics of plants is carried out by the computer simulation of the plants. The response of the main variables when the power output of a turbine is reduced stepwise from 75% to 65% is reported. The response of the Genkai No.1 plant in the power output test agreed well with the estimation by the detailed analysis, and the propriety of the detailed analysis was confirmed.

10147 Sensing elements at primary circuits of pressurized water reactors Part 1. Requirements. Sensing elements outside the active zone. Hollo, E. (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). *Energ. Atomtech.;* **29**: No. 1, 36-41(1976). (In Hungarian).

The accuracy and reliability of the information received by the operation control systems of nuclear power plants depends on the adaptation of the technology to measuring sys--tem, respectively

on the sensing elements beside the signal transmission and data processing. There is dealt with the points of view of choosing the sensing elements of pressurized water nuclear power plants, the requirements raised to these (considering the IAEA specifications), the description and use of the following sensor types set outside the active zone: integrating ionization chambers having gamma-compensation, too; electron impulse ionization chambers; BF_3 proportional chambers. The investigations are accomplished on the primary circuit containing the reactor, grouping the measured parameters according to their physical properties, because its units seem to show the greatest deviation from those of the same destinations at the conventional heat power plants according to the technology and measuring engineering.

10148 Sensing elements at primary circuits of pressurized water reactors. II. Sensing elements inside the active zone. Hollo, E. (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). *Energ. Atomtech.;* **29**: No. 3, 128-132(1976). (In Hungarian).

The nuclear instrumentation of the radioactive zone in pressurized water reactors is described. Devices for sensing thermal neutron flux are: integrating ionization chambers, electron impulse ionization chambers (max value of the measurable flux 10^8-10^{10} n/cm^{2}s), sensing elements operating by activation (range of measurements: 10^2-10^5 n/cm^{2}s), neutron thermo-couples (sensitivity: 10^{-13} mV/unit flux) hilborn- (self-powered) devices. Devices for sensing the gamma flux are: gamma ionization chambers (sensitivity: 10^{-13}-10^{-14}A/R/h, max measurable value 10^{10} R/h), gamma thermocouples (range of measurements 10^7-10^9 R/h).

10149 Sensing elements at primary circuits of pressurized water reactors. III. Measurement of thermohydraulic parameters. Hollo, E. (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). *Energ. Atomtech.;* **29**: No. 3, 132-136(1976). (In Hungarian).

Measurements for determining the thermo-hydraulic characteristics are described in the following systematization: determination of the heat output in reactors; pressure and pressure difference measurements, plane and tube membrane-, Bourdon tube-, tube spring- and Barton cell-sensors; flow meters (based on pressure-difference measurements in a choke); level-measuring sets based on pressure-difference or specific conductivity measurements; temperature measurements, thermo-couples and resistance thermometers.

10150 Sensing elements at primary circuits of pressurized water reactors Part 4. Parameter measurement in water chemistry. Hollo, E. (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). *Energ. Atomtech.;* **29**: No. 5, 228-232(1976). (In Hungarian).

The measurement of the following chemical characteristics of cooling water is determined by a described sampling technique: the concentration of impurities is determined by conductivity measurements (the construction of the measuring cell is given); pH measurements by glass-electrode; measurement of H_3BO_3 concentration by a developed apparatus having an error +-5%. From the measurements of the technological characteristics the followings are discussed: leakage measurements; elongation-, displacement- and position-measurements; vibration measurements; sensing the failure of the tube elements (Ge(Li), Si(Li) detectors).

10151 Operational experience in the Doel nuclear power plant. Berlemont, V. (Societe Reunies d'Energie du Bassin de l'Escaut (EBES), Mol (Belgium)). *Elektro-Anz.;* No. 162, 27-33(1976). (In French).

The start-up of the two units of the Doel power plant is described. Details are given on the behaviour of the control rods, vapor generators, feeding system, condenser, and other components, as well as on radioactive waste disposal.

10152 Outline of start-up of the Tihange power plant. Burtheret, J. (Centrale Nucleaire de Tihange (Belgium)). *Elektro-Anz.;* No. 162, 17-26(1976). (In French).

The different kinds of reactor start-up tests as well as their organisation are listed. Details are given on the auxiliary circuits flushing, the hydrostatic testing of primary pumps, turbines and secondary circuits. The programs for the start-up and the leak tests are described.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 10141, 10233, 10285, 10286, 10287, 10289, 10290, 10382, 10438, 10440, 10442

10153 (GA-A—13973) **Turbomachinery for the gas-turbine high-temperature gas-cooled reactor power plant.** Adams, R.G.; Boenig, F.H. (General Atomic Co., San Diego, Calif. (USA)). Jul 1977. Contract EY-76-C-03-0167-046. 51p. (CONF-770317—4). Dep. NTIS, PC A04/MF A01.

From 22. ASME international turbine conference; Philadelphia, Pennsylvania, USA (27 Mar 1977).

The Gas Turbine (or Direct Cycle) High-Temperature Gas-Cooled Reactor (HTGR) power plant uses a closed-cycle gas turbine directly in the primary coolant circuit of a helium-cooled high-temperature nuclear reactor. Previous papers have described configuration studies leading to the selection of a reactor and power conversion loop layout and the considerations affecting the design of the components of the power conversion loop. This paper discusses briefly the effects of the helium working fluid and the reactor cooling loop environment on the design requirements of the direct-cycle turbomachinery and describes the mechanical arrangement of a typical turbomachine for this application. The aerodynamic design is outlined, and the mechanical design is described in some detail, with particular emphasis on the bearings and seals for the turbomachine.

10154 (Juel—1414) **Model data set for the reflector graphite of pebble-bed reactors.** Budke, J.; Haag, G.; Hammer, W.; Mittenbuehler, A.; O'Connor, M.F.; Petersen, K. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Projekt Hochtemperaturreaktor-Brennelemente). Apr 1977. 38p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

A model data set covering the temperature range 300-800°C and irradiation dose range 0-4 x 10^{22} n/cm^2 EDN has been compiled for the reflector graphite of the OTTO-type pebble-bed high temperature reactor. The stipulated irradiation-induced changes in the properties of the model graphite are based mainly, but not exclusively, on experimental data from an extruded pitch coke graphite of British manufacture, which had been irradiated to a dose of 2.8 x 10^{22} n/cm^2 EDN. Since the initial properties of the unirradiated graphite were not known in detail, the properties of the German extruded pitch coke graphite ATR-2E from the SIGRI company were substantially used in the definition of the pre-irradiation properties of the model graphite. The main philosophy behind the compilation of the model data set was to predict as well as possible at this point in time the irradiation behaviour of the reference graphite for the reflector of the OTTO-type pebble-bed reactor and thus provide material data for stress analysis calculations. In order to allow a comparison of these stress calculations, it is recommended to use this data set which has been agreed upon among the partners in the HTB programme.

10155 (LA—6988-MS) **Irradiation test OF-2: high-temperature irradiation behavior of LASL-made fuel rods and LASL-made coated particles.** Wagner, P.; Reiswig, R.D.; Hollabaugh, C.M.; White, R.W.; O'Rourke, J.A.; Davidson, K.V.; Schell, D.H. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1977. Contract W-7405-ENG-36. 24p. Dep. NTIS, PC A02/MF A01.

Three LASL-made, substoichiometric ZrC-coated particles with inert kernels, and two high-density molded graphite fuel rods that contained LASL-made, ZrC-coated fissile particles were irradiated in the Oak Ridge Research Reactor test OF-2. The severest test conditions were 8.36 x 10^{21} nvt (E greater than 0.18 MeV) at 1350°C. The graphite matrix showed no effect of the irradiation. There was no interaction between the matrix and any of the particle coats. The loose ZrC coated particles with inert kernels showed no irradiation effects. The graded ZrC-C coats on the fissile particles were cracked. It is postulated that the cracking is associated with the low LTI deposition rate and is not related to the ZrC.

10156 (LA-UR—77-1992) **Constitutive models for concrete and finite element analysis of prestressed concrete reactor vessels.** Smith, P.D.; Anderson, C.A. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 16p. (CONF-770929—1). Dep. NTIS, PC A02/MF A01.

From Seminar on HTGR safety technology; Upton, New York, USA (15 Sep 1977).

Two constitutive models for concrete are discussed. For short-term loads, the orthotropic variable modulus model is described, and for long-term loads a viscoelastic model utilizing a Dirichlet series approximation for the creep compliance function is summarized. The orthotropic variable modulus model is demonstrated in an analysis of a PCRV head with penetrations. The viscoelastic model is illustrated with a simulation of a prestressed concrete cylinder subject to non-uniform temperatures.

10157 Method of operating a nuclear-power-generating installation with closed gas cycle and plant operated by this method. Forster, S.; Dibelius, G.; Hewing, G.; Singh, J. (to Kernforschungsanlage Juelich GmbH). US Patent 4,052,260. 4 Oct 1977. Priority date 12 Jun 1975, German, Federal Republic of (F.R. Germany). 16p.

A nuclear power-generating installation is disclosed which comprises three power-generating turbines which are operated by three partial gas streams heated in separate passages of a nuclear reactor. After traversing the power-generating turbines the partial gas streams are cooled in respective recuperative heat exchangers to recover residual useful heat therefrom and are combined into a lesser number of gas streams each of which is subjected to at least two

compression stages with at least one intervening cooling stage in which all of the gas is combined to flow as a total gas stream through at least one such cooler. Following the last compression stage the gas is again subdivided into three partial streams for preheating in the aforementioned recuperative heat exchangers before traversing the nuclear reactor for the main heating. 20 claims, 13 figures.

10158 Nuclear power installations. George, B.V.; Drayrer, C.J. (to Nuclear Power Co. (Whetstone Ltd.)). US Patent 4,048,012. 13 Sep 1977. Priority date 24 Aug 1972, United Kingdom of Great Britain and Northern Ireland (UK). 6p.

In a nuclear-reactor power-generating installation having a main and an auxiliary steam-generating boiler, both arranged to receive heat from the reactor core (for example by circulation of reactor coolant gas), and having a turbogenerator which includes a multistage steam turbine through whose stages the steam from the main boiler passes in sequence, there being a steam reheater unit connected between two of the stages to provide reheating of the steam from the main boiler, the invention provides that the auxiliary boiler is connected to supply to the reheater unit steam which reheats the said steam from the main boiler. 5 claims, 2 figures.

10159 Molten fuel-salt reactor. Blum, J.M.; Grenon, M.; Ventre, E. (to Electricite de France (Service National); Pechiney Ugine Kuhlmann). US Patent 4,045,286. 30 Aug 1977. Priority date 24 Dec 1974, France. 8p.

In a molten-salt reactor, a common vessel contains the reactor core, a neutron-moderating mass pierced by passages for the circulation of the fuel salt, at least one primary heat exchanger which is located close to the reactor core and through which the hot fuel salt passes after discharge from the core, and pumps for circulating the cold fuel salt from the heat exchangers back into the reactor core. The free spaces defined within the reactor vessel between the core, the heat exchangers and the pumps except for the passages in which the molten fuel salt is circulated are packed with material which is compatible with the fuel salt. 4 claims, 3 figures.

10160 Methane on site as a nuclear power station spin off. Webster, H. (Clarke Chapman - John Thompson Ltd., Gateshead (UK)). *Proc. Fac. Sci. Tokai Univ.;* **23**: No. 6, 28-30(Jun 1977).

Methane is used as a corrosion inhibitor for graphite oxidation in AGR reactors. It is however broken down by radiolysis and must be replaced. The on-site production and reaction data for the catalytic synthesis of methane from carbon dioxide and hydrogen is briefly described.

10161 First Hunterston AGR should have high availabilities. Masters, R. *Nucl. Eng. Int.;* **22**: No. 258, 25-27(Jun 1977).

The performance of the first of two 660 MWe AGR units at Hunterston B, after 16 months operation, is discussed. Some of the problems encountered such as de-aerator instability control of gas composition and fuel-stringer vibration are briefly discussed. Losses in availability were almost entirely due to faults on peripheral and conventional plant. Safety circuits operated satisfactorily, and fuel performance was extremely good.

10162 Future of the high temperature reactor. Shepherd, L.R. *Energy Dig. (London) ;* **6**: No. 3, p. 4-7, 24(Jun 1977).

The characteristics of high temperature gas-cooled reactors and their current development status are summarized. Core structures and fuel elements, and the coated fuel particle are described, with particular reference to reliability and experience in keeping the primary circuit activity at an extremely low level. The future prospects for the HTR are discussed in relation to forecast world energy requirements, uranium availability, fuel cycles, efficiency, the gas turbine, and the use of HTR to carry out high temperature chemical processes.

10163 Work starts in SuperPhenix at the Creys-Malville site. Banal, M. *Nucl. Eng. Int.;* **22**: No. 257, 41-45(May 1977).

Details are given of the 1200 MWe SuperPhenix fast breeder reactor. Design principles are outlined and essential differences between SuperPhenix and Phenix are discussed: the main differences are the new heat exchanger design and the containment system. Descriptions are given of the site layout, core, nuclear steam supply system, main secondary circuits and the fuel handling system. Safety features which are discussed include licensing procedure, core surveillance, decay heat removal and the containment system. A tables of parameters is included.

10164 HTR line in the Federal Republic of Germany. Harder, H.; Mueller, W. (Hochtemperatur-Reaktorbau G.m.b.H., Mannheim (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **22**: No. 4, 195-198(Apr 1977). (In German).

Extensive constructive and operational experience with the HTR line in the FRG make it possible to realize all basic types of this reactor line on a technical scale. The operational experience is based on the AVR test reactor. In ten years of operation, the pebble-bed construction and the functioning of the power-generating HTR were tried and proved, and the highest coolant temperatures ever reached in a power station were reached and maintained. This plant also helped to prove the high inherent safety potential of HTR-type reactors. The next step will be the THTR prototype now under construction and the transition to high-power HTR plants. HTR-type reactors for direct coupling with a helium turbine (HTR) and for nuclear process heat utilization are being developed and planned.

10165 Schmehausen power station site and its structures. Krolewski, H. (Vereinigte Elektrizitaetswerke Westfalen A.G. (VEW), Dortmund (Germany, F.R.)). *VGB Kraftwerkstech.;* **57**: No. 4, 259-269(Apr 1977). (In German).

From VGB conference 'construction meeting 1976'; Dortmund, Germany, F.R. (20 Oct 1976).

At Hamm-Schmehausen three fossil fuel fired units are in operation at present. The Thorium High Temperature Reactor (THTR) of 300 MW electrical capacity is under construction alongside. The licensing procedure for a further nuclear unit (1300 MW pressurised water reactor) is progressing and the plant supply contract has been placed. In the structural engineering field the following items; inter alia, are of particular interest: 1) The pre-stressed concrete pressure vessel of the THTR, 2) dry cooling (with the cooling tower shell in the form of a cable net); 3) supply by artificial means with cooling tower make-up water; 4) the situation on the river with a relatively small passage of water; 5) the information centre; 6) the relative proximity to mining areas and; 7) the application of the new North West Countryside Act.

10166 Project of a continuation store for burned-up fuel element from high-temperature reactors. Klein, D.; Pirk, H. (Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.)). *Kerntechnik;* **19**: No. 4, 180-187(Apr 1977). (In English, German).

The project described concerns the technical concept and preliminary design of a store for burned-up fuel elements of the thorium high-temperature reactor THTR-300 and the AVR pebbel bed reactor in Juelich and also absorber and moderator elements of the thorium high-temperature reactor THTR-300. The store is designed so that the afterheat of the fuel elements which is taken up with air in free convection can be passed through the cell walls to the atmosphere, that by geometrically safe arrangement of the fuel elements criticality safety is ensured and that sufficiently dimensioned shielding walls protect the operating personnel against ionizing radiation. The capacity is dimensioned for the storage of the fuel elements of the reactor accumulated over ten years of operation.

10167 Improvements in or relating to helium-cooled nuclear reactors. Trowse, F.W.; Palmer, J.E.M. (to UKAEA). British Patent 1469104/A/. 30 Mar 1977. 2p.

Reference is made to high temperature He-cooled reactors (HTRs). In such reactors carbon or graphite forms an essential part of the core and this carbon is exposed to a flow of He through the core. The He normally contains water vapour as an impurity and this cannot readily be removed. The water vapour, and other contaminants in the coolant, are considered to have a corrosive effect on the carbon. This specification seeks to reduce this corrosive effect. The exposed carbon is selected so as to have a pore diameter such that the coolant flow has a velocity profile such that a sub-layer of laminar flow is maintained over the surface of the exposed carbon. The pore diameters should not be greater than 25 μ, and most of the pore volume should be taken up by pores of 1 μ diameter or less, thus reducing the pore diameters to below the level where diffusion of water vapour into the pores is significant. Some experimental work confirming these findings is described.

10168 Nuclear reactors. Prescott, R.F. (to Nuclear Power Co. (Whetstone) Ltd. (UK)). British Patent 1468182/A/. 23 Mar 1977. 17p.

Reference is made to reactor containment vessels and the provision of improved thermal insulation on their inner surfaces, the arrangement described being particularly applicable to concrete pressure vessel of a gas cooled high temperature reactor or fast reactor, although it may also be applicable to a liquid cooled fast reactor. The internal surface of the containment vessel has a metal liner, having thermal insulation comprising a layer of ceramic bricks or tiles with one or more layers of compressible porous thermally insulating material interposed between the bricks and the metal liner. Retention means are provided by studs, secured on the metal liner and projecting through the interposed layer or layers, and by securing means by which the bricks are individually secured by the studs, the studs and securing means themselves being insulated from the vessel interior by proportions of the thermal insulation. The securing means exert forces on the bricks to hold the interposed layer or layers under compression between the bricks and the metal liner. There is provided adjacent to each stud a resilient device, that may consist of a helical spring, held in compression between the bricks and the metal liner. Full constructional details are given.

10169 Stress analysis and constructional design of high pressure vessels, apparatus and atomic reactors by means of photoelastic inves-

tigations. Steinchen, W. (Gesamthochschule Kassel (Germany, F.R.)). *Z. Werkstoffiech.;* 8: No. 2, 55-63(Feb 1977). (In German).

From 18. exhibition and conference of chemical apparatus. ACHEMA '76; Frankfurt am Main, Germany, F.R. (20 - 26 Jun 1976).

The description of the versatile advantages and the existing experience with photoelastic examinations of components in mechanical and apparatus engineering should give evidence that improvements as well as new designs and designing of variants can be experimentally analyzed. The decision, whether experimental or computer-supported design methods are to be applied for strength and lifetime assessment of components, can in practice only be taken according to the individual case. In principle, the combination of both methods appears to be a sensible supplementation.

10170 Development of in-core conduction calorimeters for fission output distribution measurement in the fuel element of the A-1 nuclear power plant reactor. Dach, K.; Hajsman, V.; Horak, J.; Jirousek, V. (Skoda, Plzen (Czechoslovakia). Zavod Vystavba Jadernych Elektraren). *Jad. Energ.;* 22: No. 9, 330-335(Sep 1976). (In Czech).

The theoretical, design and production aspects are described of the development of reactor microcalorimeters. Some results of the experimental testing on the WWR-S reactor at Rez are given. The design technology aspects are summed up of the development of the calorimetric probe for measuring the distribution of the fission power output in the fuel element of the A-1 nuclear power plant reactor. The design makes possible the manufacture of calorimeters with various detection bodies with different sensitivity at the same outer dimensions. The probe may be installed instead of any fuel pin, this in an element of either the central or the peripheral reactor zone.

10171 System analysis of very high temperature experimental reactor plant. Iino, T.; Onuki, Y.; Wasaoka, T.; Ozawa, T.; Yoshie, S. (Kawasaki Heavy Industries Ltd., Kobe (Japan)). *FAPIG (Tokyo);* Nc. 82, 14-18(Aug 1976). (In Japanese).

Japan Atomic Energy Research Institute is carrying out the research and development of a multi-purpose high temperature gas reactor, as it contributes to the diversification of energy sources and the effective use through the production of nuclear thermal energy, and also it is useful for saving energy and resources and preserving the environment. Diverse operational modes are required for the experimental reactor because of the multi-purpose. The demonstration test for multi-purpose utilization, the irradiation test of high temperature-resistant fuel and materials, and the system safety test are planned for the experimental reactor. The main cooling system comprises two loops with helium. The plant in operation is controlled with four control systems, namely reactor output control, reactor inlet gas temperature control, steam pressure control, and drum level control. The statical characteristics of the plant are analyzed by heat and mass balance computation, and the basic conditions are set by taking the operational modes, system constitution, and plant control into account. The parameter survey regarding the operational characteristics was carried out in the range as wide as possible, and the effect of the capacity margin of an intermediate heat exchanger on the operational modes was studied. Both the temperature margin and the heat transfer area margin must be considered in the design.

10172 Experience in constructing large nuclear power plant in the USSR. Dollezhal, N.A.; Emel'yanov, I.Ya. *At. Energ. (USSR);* 40: No. 2, 117-126(Feb 1976). (In Russian).

Experience is generalized in the development and improvement of channel carbon-uranium reactors, from the reactor of the world's First Atomic Station to the world's biggest RBMK-type reactors. The technical characteristics and advantages of the RBMK-1000 reactor are given as well as the main positive results obtained while developing this type of reactor and in the process of running-in work in the first and the second block of the Leningrad Atomic Station. The technical feaibility of increasing the power of the RBMK reactor up to 1500 Mw (el.) without changing the reactor design as a whole. The technical characteristics and positive qualities of a 200 Mw (el.) ring-type lumped RBMK-2000 reactor being designed are considered. Great advantages of a nuclear superheating of steam envisaged in this reactor are shown. Enumerated are the prerequisites for further improvements in channel reactors.

10173 Nuclear start-up of the Leningrad-2 reactor of the Leningrad atomic power station. Emel'yanov, I.Ya.; Egizarov, M.B.; Ryabov, V.I. (and others). *At. Energ. (USSR);* 40: No. 2, 127-132(Feb 1976). (In Russian).

The main stages are described of the physical startup of the reactor in the second block of the Leningrad Atomic Station named after V.I. Lenin. The preparation of the reactor for the startup is described, as well as the process of its loading, the initial load containing 1455 fuel element assemblies (FEA) (eight channels have been left unloaded). The influence of various parameters on the reactivity has been analysed and it has been revealed that decrease in reactivity is mainly due to decrease in the density of the graphite. An evaluation of the "steam" effect of reactivity in the cold state has been made; dewatering of the cooling circuit reduces the reactivity by 2%. The total efficiency of the control and safety rods inserted has been determined; it has turned out to be 8.9%. A comparison of the experimental and calculated fields of energy release obtained with the BOKR-COBZ and QUAM-3 programmes has shown that the RMS discrepancy between the measured and calculated power of FEA's for both programmes is 9.7%. Comparative results are given of the physical start up of the first-and the second-block reactors of the Leningrad atomic station.

10174 Significance of high-temperature reactors in the scientific and technological progress of power engineering. Dollezhal, N.A.; Koryakin, Yu.I. *At. Energ. (USSR);* 40: No. 2, 133-144(Feb 1976). (In Russian).

Factors are presented which motivate the development of high-temperature nuclear-power engineering. They are divided into two groups: 1) the requirement of enhancing the economy of nuclear-power engineering and 2) external factors resulting from the interrelation between nuclear-power engineering and the environment or connected with the need to displace organic fuels from energy-consuming technological processes. A higher efficiency of the thermal cycle than in any water-cooled reactors known is ensured (41-43% vs 31-33%). The low pressure of the gas coolant permits the use of a ferroconcrete vessel which accomodates all the basic equipment of the first circuit (the integrated packing). A direct gas turbine cycle, possible already at helium temperatures of 750 to 850 deg C, will allow a considerable reduction in the cost of power generation. There is every reason to fear that the specific cost of reactors with a liquid metal coolant will exceed that of thermal reactors by over 50 to 60%, that is why some countries are considering gas-cooled fast reactors as a possible alternative.

10175 Nuclear fuel block. Matsubara, T.; Goto, M. (to Nuclear Fuel Industries Ltd., Tokyo (Japan)). Japanese Patent 1976-113091/A/. 31 Mar 1975. 4p. (In Japanese).

To avoid bending of fuel rods and prevent fissures in sleeve portions, a nuclear fuel block, in which hollow cylindrical nuclear fuel rods each consisting of a hollow cylindrical nuclear fuel compact and a concentric graphite cover layer surrounding and integral with the compact are buried in a graphite block throughout their length at a uniform spacing from one another.

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

REFER ALSO TO CITATION(S) 10396

10176 Yesterday's noise: today's signal. Serdula, K.J. Chalk River, Ontario; Atomic Energy Canada Limited (Nov 1976). 39p.

It is shown that yesterday's "unwanted noise" in signal can be used today to improve plant performance. This "noise signal" can yield information on both the dynamic and the steady-state performance of the system. The concept and characteristics of signal noise and the benefits that can be obtained through the use of signal noise are discussed. Results from practical applications to nuclear systems are given with emphasis on applications to the CANDU-BLW "CANada Deuterium Uranium--Boiling Light Water coolant" reactor, Gentilly-1. 2 refs.

10177 Nuclear reactors. Middleton, J.E. (to Nuclear Power Co. (Whetstone) Ltd.). US Patent 4,046,628. 6 Sep 1977. Priority date 25 Oct 1974, United Kingdom of Great Britain and Northern Ireland (UK). 10p.

In a water-cooled pressure-tube reactor in which each fuel-containing pressure tube is included in one of two main coolant circuits each of which comprises a bottom header supplying coolant water to the pressure-tube lower ends, a steam drum to which the pressure-tube upper ends are connected, main circulator means pumping water from the steam drum to the bottom header, further pump means pumping an auxiliary coolant water flow from the steam drum of each coolant circuit directly into the pressure tubes of that circuit in the form of spray cooling in such pressure tubes, with the bottom headers of the two circuits interconnected and main feedwater pumps supplying make-up water to the steam drums to replace generated steam, the invention provides, between the main feedwater pumps and the steam drums, water inlet valves which are controlled by pressure in the coolant circuits and are arranged to close in response to a fall in such pressure, and also provides further connections arranged to supply feedwater directly, in the event of such pressure fall, from the main feedwater pumps to the bottom headers and into the pressure tubes of each coolant circuit as the said spray cooling therein. 7 claims, 4 figures.

10178 Nuclear reactors. Middleton, J.E. (to Nuclear Power Co. (Whetstone) Ltd.). US Patent 4,046,627. 6 Sep 1977. Priority date 29 Apr 1974, United Kingdom of Great Britain and Northern Ireland (UK). 10p.

In a nuclear reactor having the fuel disposed within a large number of pressure tubes fed in parallel with liquid coolant which is partly vaporized while flowing through the pressure tubes, the invention provides a coolant-supply header assembly comprising parallel-extending sub-header pipes which at their ends are connected by end pipes and which have water outlets (for connection to the individual pressure tubes) distributed along their lengths, and header pipes each extending transversely across the sub-header pipes at spaced intervals therealong and having a water inlet and a plurality of branch pipes each of which connects to a respective one of the sub-header pipes. Preferably, a plurality of main coolant circuits are provided, each including such a header assembly, and the fuel in each pressure tube is cooled not only by the main coolant flow from one of the header assemblies but also by spray cooling utilizing coolant drawn from another of the coolant circuits, with each circuit maintaining a balance between coolant received as spray cooling in its own pressure tubes and coolant drawn off for spray cooling of other pressure tubes. 12 claims, 4 figures.

10179 World's reactors no. 71: Point Lepreau CANDU PHWR 600 MWe. *Nucl. Eng. Int.;* **22**: No. 258, 49-50(Jun 1977).

A coloured cut-away wall chart is presented of the Point Lepreau, CANDU type 600 MWe nuclear generating station. Main parameters are listed.

10180 Site-specific design features. Carik, N.G.; Parfitt, A.W. (Canatom Ltd., Montreal, Quebec (Canada)). *Nucl. Eng. Int.;* **22**: No. 258, 48-53(Jun 1977).

Point Lepreau nuclear generating station is the same basic design as the standard CANDU 600 MWe plant, and is similar to Gentilly-2. However, many features of the service building and turbine buildings are designed specifically to meet the requirements of the site and to allow for a second unit. The station layout is described and details are given of the service building, the electrical system, and the cooling water system. Point Lepreau is the first Canadian nuclear plant to use sea-water cooling and the system is compared with that for a similar CANDU type using fresh water.

10181 AECL assesses the cost of decommissioning. Glen, R. *Nucl. Eng. Int.;* **22**: No. 258, 27-28(Jun 1977).

A standard 600 MWe Candu could be in service for well over 35 years. The actual life is guesswork. The total cost of decommissioning at 1976 prices could be $60M, half being for dismantling the reactor. Perfection of the thorium cycle could give added life.

10182 Construction progress. MacPhail, A. (New Brunswick Electric Power Commission, Fredericton (Canada)). *Nucl. Eng. Int.;* **22**: No. 258, 53-56(Jun 1977).

The progress construction work on the Point Lepreau nuclear station is described. Summaries are included of major equipment suppliers, essential dates, construction and contracts schedules. The management of the project is briefly described.

10183 Standard CANDU 600 MW(e) nuclear plant. Renshaw, R.H.; Smith, E.C. (Atomic Energy of Canada Limited). *Nucl. Eng. Int.;* **22**: No. 258, 45-48(Jun 1977).

Point Lepreau nuclear power plant is a standard 600 MWe CANDU type, the first of which was Gentilly-2. Descriptions are given of the reactor heat transport system, fuel and fuel handling, the control system, instrumentation and power system. Reactor safety systems and seismic protection are briefly discussed.

10184 Why New Brunswick opted for nuclear power. Thompson, T.S. (New Brunswick Electric Power Commission, Fredericton (Canada)). *Nucl. Eng. Int.;* **22**: No. 258, 41-45(Jun 1977).

The background to the decision to build a nuclear power station at Point Lepreau, in New Brunswick, and its role in the existing and future power system development is discussed. Details are given of the site selection and the process of environmental assessment. Attention is drawn to the cooling water system which uses sea water for condenser cooling. Stages in the process of public participation in the project is described.

10185 Fueling of D_2O reactors. Pt. 2. Dusch, F.; Moldaschl, H. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). *Atomkernenergie;* **29**: No. 4, 259-260(1977). (In German).

The transition of fresh natural uranium cores to burnup equilibrium is demonstrated in the case of fueling for the nuclear power plant Atucha (Argentina). The loading operations were determined by use of the heterogeneous 3-D code TRISIC. A stationary burnup distribution was already obtained after approx. 420 fpd. During the last 18 month (April 1975-September 1976) the availability factor was 94%, the capacity factor of 92% was only a little below this value. The number of defective fuel pins which orrurred up to the present is low, having a failure rate below 0,05%.

10186 Design criteria and analysis methods for a CIRENE reactor core. Bonalumi, R.A.; Casagrande, I. (Centro Informazioni Studi Esperienze, Milan (Italy)); Broggiato, A. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)); Valdacca, V. (Nucleare Italiana Reattori Avanzati (NIRA) Genova, Italy). *Energ. Nucl. (Milan);* **23**: No. 8, . 437-446(1976).

This paper describes the design criteria and the analysis methods of a CIRENE reactor core. The design criteria are based on thermal-hydraulic considerations, and imply, in particular, a limitation of the Minimum Critical Power Ratio for the fuel channel. A survey is given in this paper of the validity of the adopted thermal-hydraulics correlations and the main neutronic and thermal-hydraulic calculation tools are illustrated, the accuracy and efficiency of which are also indicated.

10187 Metallurgical aspects of the electroslag welding of the A 1 nuclear-reactor pressure vessel from the viewpoint of filler metals. Zeke, J. *Zvaranie;* **24**: No. 11, 334-338(Nov 1975). (In Slovak).

The choice of welding wire and flux for the electroslag welding of a nuclear-reactor pressure vessel is discussed. The effect of wire and flux compositions on the metallurgical processes occurring in the weld pool were studied.

10188 Pressure tube type reactor support structure. Kishi, T.; Oguchi, I.; Shibado, E. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-120398/A/. 16 Apr 1975. 3p. (In Japanese).

The size of a reactor is reduced by adopting a reactor structure which depends from shielded shield concrete. A plurality of suspension beams are buried in shield concrete and connected by bolts to a shield member in the lower portion of a reactor. This construction facilitates the arrangement of the primary cooling duct and thus permits a reduction in the size of the reactor and shielded concrete.

10189 Breakage detection system for a nuclear reactor. Hirose, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-108198/A/. 19 Mar 1975. 3p. (In Japanese).

Disclosed is a system to prevent fusion of fuel by providing a pressure switch with a double-wall pressure tube structure so as to directly detect the breakage of the pressure tube from the pressure of the cooling material. In the normal operation of pressure tube type reactors by a cooling medium supplied to a vapor drum is pressurized by a pump and fed through a lower header into a pressure tube. The heat of fuel in fission is returned into a vapor drum in the form of two-phase flow of vapor and liquid by making use of thermal neutrons. In this way, when the inner side pressure tube in contact with the cooling medium is broken, a pressure switch for detecting the pressure between the inner and outer side pressure tubes is adapted to directly detect the pressure of the cooling material and transmit it to a reactor protector means. As a result, an emergency reactor stop signal is transmitted to the control rod drive means for emergency insertion of a control rod, thereby preventing fusion of the fuel within the pressure tube.

10190 Fuel assemblies. Katayanagi, D.; Watari, Y.; Hirao, S. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-108191/A/. 19 Mar 1975. 3p. (In Japanese).

An absorber is provided at the leading end on the introducing side of a fuel assembly thereby restraining flux output density of upper fuel elements at the time of replacing fuel during the operation of reactor. Upper and lower tie plates and a plurality of fuel pins connected therebetween constitute an integral fuel assembly. A clad tube forming the fuel pin is interiorly filled with a multitude of fuel pellets (for example, 1.5% enriched uranium), opposite ends of which are filled with adiabatic pellets such as alumina (Al_2O_3). In this case, a neutron absorber, for example, such as boron carbide (B_4C) of thickness 10cm, is filled between the adiabatic pellet at the leading end (upper end) in the mounting direction of the fuel assembly and the fuel pellet at the foremost end. When the new fuel assembly constructed as described above is inserted into the central portion of the core where flux output density is highest, axial output distribution at this time is considerably decreased in output peak at the upper part of the fuel element by the action of the absorber, as compared with the prior art.

10191 Heavy water reactor. Nishida, K.; Fujie, T. (to Mitsubishi Atomic Power Industries, Inc., Tokyo (Japan)). Japanese Patent 1976-102796/A/. 6 Mar 1975. 3p. (In Japanese).

Provision is made for one coolant inlet pipe and one coolant outlet pipe for a group of pressure pipes thereby to simplify design, fabrication and maintenance of the reactor. Coolant circulating paths and a reactor core are disposed within a multi-cavity type prestressed concrete reactor vessel thereby to obviate the use of complicated and bulky coolant piping systems.

10192 Reactor fuel assembly. Haga, T.; Miyawaki, Y. (to Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Japanese Patent 1976-101689/A/. 5 Mar 1975. 4p. (In Japanese).

To uniformly suppress local output peak in the fuel assembly of a pressure type heavy-water-moderated power reactor and permit free control of output distribution and regulation of reactivity. Fuel pellets containing burnable poison such as gadolinium are dispersed in several of the fuel rods. When the pellets are locally and regularly

arranged, for instance, in the outermost fuel layer, it is possible to uniformalize the local output peaking of the outer most layer of the fuel assembly and freely adjust the output distribution and restrain the reactivity by varying the size, distribution and density of the pellets.

10193 Method of loading a neutron source in a pressure tube type reactor. Hayashi, K.; Wako, H. (to Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Japanese Patent 1976-101694/A/. 5 Mar 1975. 4p. (In Japanese).

A method is disclosed to enable a neutron source to be easily mounted and exchanged in a safe manner by mounting the neutron source within the pressure tube and thus dispensing with a neutron source guide duct and neutron source assembly replacement means. A neutron source assembly having an outer diameter capable of being snugly fitted ,nto the pressure tube is used and is inserted into the pressure tube occupied by a fuel assembly by making use of fuel replacing means. The neutron source assembly is provided with upper and lower handling heads and has a cylindrical barrel, in which a neutron source is removably accommodated. For varying the neutron intensity only the neutron source may be replaced without the need of changing the whole assembly, thus resulting in less nuclear waste.

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 10268, 10287, 10377, 10379, 10381, 10383, 10384, 10393, 10395, 10427, 10428, 10429, 10430, 10431, 10432, 10436, 10437, 10441, 10446, 10447, 10448, 10449, 10468, 10478, 10490, 10491, 10581

10194 (AERE-R—8020) **Continuous method of determining the thermodynamic activity of carbon in sodium.** Asher, R.C.; Kirstein, T.B.A.; Tolchard, A.C. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Jan 1977. 12p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The Harwell Carbon Meter (HCM) provides a continuous indication of the thermodynamic carbon activity in liquid sodium. This information is important with respect to the carburization and decarburization of steel components of the sodium circuits of sodium cooled Fast Reactors. A description of the HCM is given. It has been shown to respond rapidly to changes in carbon activity, to give an output which is in satisfactory agreement with spot calibrations using nickel "tabs" and to operate reliably without failure for long periods.

10195 (ANL-AFP—34) **Advanced fuels program. Quarterly progress report, October—December 1977.** Kittel, J.H. (comp.). (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 196p. .

Progress is summarized in the following LMFBR mixed carbide and mixed nitride fuel development tasks: (1) design, surveillance, and evaluation of steady-state irradiation tests; (2) off-normal irradiation testing; (3) performance modeling; (4) design studies for FFTF and CRBR; (5) design studies for large LMFBR plants; (6) fuel properties; (7) design of irradiation tests in FFTF; (8) fuel chemical stability; and (9) safety studies. (DG)

10196 (ANL-AFP—35) **Advanced fuels program. Quarterly progress report, January—March 1977.** Kittel, J.H. (comp.). (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 239p. .

Progress is summarized in the following LMFBR mixed carbide and mixed nitride fuel development tasks: (1) design, surveillance, and evaluation of steady-state irradiation tests; (2) off-normal irradiation testing; (3) performance modeling; (4) design studies for FFTF and CRBR; (5) design studies for large LMFBR plants; (6) fuel properties; (7) design of irradiation tests in FFTF; (8) fuel chemical stability; and (9) safety studies. (DG)

10197 (BN—7612-04) **Results of the post-irradiation examinations of the Rapsodie I experiment fuel pins.** Haas, V.; Gaube, M.; van de Velde, J.; Ketels, J.; van Loon, C. (Societe Belge pour l'Industrie Nucleaire, Brussels). 1976. 25p. Dep. NTIS (US Sales Only), PC A02/MF A01.

An experiment sponsored by GfK, BELGONUCLEAIRE and INTERATOM has been carried out in the French reactor Rapsodie from February 1971 to September 1972, in the frame of the R and D program for the fast breeder prototype reactor SNR. This experiment consisted in the irradiation of two bundles of 34 mixed oxide pins each, with spacer grids and tie-rods, up to a peak burn-up of 10.6 a/o and a peak total neutron fluence of 8×10^{20} mm^{-2}, corresponding to a peak fast fluence (E>0.111 MeV) of 6.4×10^{20} mm^{-2}. The post-irradiation examinations showed that the cold-worked WNr. 1.4970 cladding stainless steel has a lower irradiation induced swelling than the solution-annealed WNr. 1.4988. Important inelastic deformations of both types of claddings have been observed; the largest part of these deformations can be explained by the in-pile creep. A mechanical interaction between the fuel and the cladding is not excluded in the case of the pins with the cladding steel WNr. 1.4970. The destructive examinations emphasized the influence of the pellets initial stoichiometry on the fission products migration, on the plutonium radial distribution and on the fuel-cladding chemical interaction. An interaction between the fuel and the blanket pellets due to the cesium migration and to the formation of cesium uranates, leading to local cladding strains, has been noticed. These phenomena, as well as the chemical interaction between the fuel and the cladding, have been investigated by extensive microprobe analysis. Finally, the fuel restructuration has been analysed and interpreted as a function of the fuel characteristics, irradiation conditions and cladding deformations.

10198 (CONF-760646—, pp 248-254) **UF_6 breeder reactor power plants for electric power generation.** Rust, J.H. (Georgia Inst. of Tech., Atlanta); Clement, J.D.; Hohl, F. Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

The reactor concept analyzed is a $^{233}UF_6$ core surrounded by a molten salt (Li^7F, BeF_2, ThF_4) blanket. Nuclear survey calculations were carried out for both spherical and cylindrical geometries. A maximum breeding ratio of 1.22 was found. Thermodynamic cycle calculations were performed for a variety of Rankine cycles. Optimization of a Rankine cycle for a gas core breeder reactor employing an intermediate heat exchanger gave a maximum efficiency of 37 percent. A conceptual design is presented along with a system layout for a 1000 MW stationary power plant. The advantages of the GCBR are as follows: (1) high efficiency, (2) simplified on-line reprocessing, (3) inherent safety considerations, (4) high breeding ratio, (5) possibility of burning all or most of the long-lived nuclear waste actinides, and (6) possibility of extrapolating the technology to higher temperatures and MHD direct conversion.

10199 (CONF-760646—, pp 255-262) **Georgia Institute of Technology research on the gas core actinide transmutation reactor (GCATR).** Clement, J.D. (Georgia Inst. of Tech., Atlanta); Rust, J.H.; Schneider, A.; Hohl, F. Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

The Gas Core Actinide Transmutation Reactor (GCATR) offers several advantages including (1) the gaseous state of the fuel may reduce problems of processing and recycling fuel and wastes, (2) high neutron fluxes are achievable, (3) the possibility of using a molten salt in the blanket may also simplify the reprocessing problem and permit breeding, (4) the spectrum can be varied from fast to thermal by increasing the moderation in the blanket so that the trade-off of critical mass versus actinide and fission product burnup can be studied for optimization, and (5) the U^{233}-Th cycle, which can be used, appears superior to the U^{235}-Pu cycle in regard to actinide burnup. The program at Georgia Tech is a study of the feasibility, design, and optimization of the GCATR.

10200 (CONF-770807—34) **Dynamic instability analysis of axisymmetric shells by finite element method with convected coordinates.** Hsieh, B.J. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 12p. Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, USA (15 Aug 1977).

The instability of axisymmetric shells has been used in engineering fields as a safety device such as the rupture discs used in the LMFBR (Liquid Metal Fast Breeder Reactor) design to relieve the excessive pressure caused by the water and sodium reaction when there is a leak in the piping system. Hence, the analysis of the instability of shells under time varying loading is becoming more and more important. However, notorious discrepancy has been observed between various analytical predications and experimental results for the buckling of shells. Various theories have been proposed to explain these discrepancies. Most of these theories are concerned with two aspects: initial imperfections and asymmetric responses. Both theories do narrow the gap between theoretical and experimental results; however, the remaining discrepancy is still not small. Other possible causes of this discrepancy have to be studied- among them, the boundary conditions. It has been pointed out that the slip at the boundary may have noticeable effect on the transient behavior of a plate. In this paper, the effect of various boundary conditions on the dynamic instability of axisymmetric shells is studied using the numerical discretization technique—convective finite element method.

10201 (CONF-771052—1) **Material properties requirements for LMFBR structural design: general considerations and data needs.** Pugh, C.E.; Purdy, C.M. (Oak Ridge National Lab., Tenn. (USA); Energy Research and Development Administration, Washington,

D.C. (USA)). 1977. Contract W-7405-ENG-26. 46p. Dep. NTIS, PC A03/MF A01.

From International working group on fast reactors (IAEA/IWGFR) specialists meeting; Bensburg, F.R. Germany (17 Oct 1977).

A statement is given of material properties information needed in connection with the structural design technology for liquid-metal fast breeder reactor (LMFBR) primary circuit components. Implementation of current analysis methods and criteria is considered with an emphasis on data and data correlations for performing elastic-plastic and creep analyses, for establishing allowable stress limits, and for computing creep-fatigue damage. Further development of the technology is discussed in relation to properties information. Emphasis is placed on improved constitutive equations for representing inelastic material behavior, on procedures for treating time-dependent fatigue, and on criteria for creep rupture. The properties are generally discussed without regard to specific alloys, since most categories of information are needed for each major structural material. Some sample experimental results are given for type 304 stainless steel and 2¼ Cr-1 Mo steel.

10202 (HEDL-SA—1175) **U. S. programs on reference and advanced cladding/duct materials.** Bennett, J.W.; Holmes, J.J.; Laidler, J.J. (Hanford Engineering Development Lab., Richland, Wash. (USA)). May 1977. Contract EY-76-C-14-2170. 21p. (CONF-770641—13). Dep. NTIS, PC A02/MF A01.

From Conference on radiation effects in breeder reactor structural materials; Scottsdale, Arizona, USA (19 Jun 1977).

Two coordinated national programs are presently in place in the United States for development of reference and advanced cladding and duct alloys for near-term and long-term LMFBR applications. A number of government, industrial and university laboratories are active participants in these two ERDA-sponsored programs. The programs are administered by ERDA through a task group organization, with each task group representing a particular technical activity and the membership of the task group drawn from among the laboratories with active involvement in that activity. Technical coordination of the two programs is provided by the Hanford Engineering Development Laboratory. The National Reference Cladding and Duct Program is charged with the responsibility for development of the required technology to permit full utilization of the reference material, 20 percent cold-worked Type 316 stainless steel, in early LMFBR core applications. The current schedule calls for full evaluation of FFTF-related design base data prior to full-power operation of FFTF in early 1980, followed by a confirmation in early 1983 of reference material performance capabilities for initial-core CRBRP applications. Comprehensive evaluation of reference material performance to commercial plant goal fluence levels will be complete by 1985. The National Advanced Alloy Development Program was instituted in 1974 with the objective to develop, by 1986, advanced cladding and duct materials compatible with advanced fuel systems having peak burnup capabilities up to 150 MWD/kg and doubling times of 15 years or less. Screening of a large number of potential alloys was completed in mid-1975, and there are presently 16 candidate alloys under active investigation.

10203 (HEDL-SA—1268) **In-reactor behavior of materials used to control fuel-cladding chemical interaction.** Wilson, C.N.; Gibby, R.L.; Lawrence, L.A.; Weber, E.T. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 22 Aug 1977. Contract EY-76-C-14-2170. 27p. (CONF-770958—1). Dep. NTIS, PC A03/MF A01.

From American Ceramic Society fall meeting; Hyannis, Massachusetts, USA (26 Sep 1977).

Niobium, vanadium, chromium and titanium metals were irradiation tested in various configurations as candidate oxygen buffer/getter materials in LMFBR fuel pins. Test results indicate in-situ oxidation of buffer/getter materials with specific materials and configurations preventing cladding attack. Some placement configurations were ineffective due to low oxygen mobility. A relative preference for buffer/getter reaction with fission product cesium was also noted.

10204 (KFK—2416) **Fuel element of the LMFBR.** Karsten, G. (ed.). (Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Schneller Brueter). 1976. vp. (In German). (CONF-7610135—). NTIS.

From KTG technical day on fuel element of the sodium-cooled breeder; Karlsruhe, F.R. Germany (28 Oct 1976).

Separate abstracts are included for each of the individual papers presented.

10205 (KFK—2416, pp 89-95) **Development of cladding and structural materials.** Anderko, K. 1976. (In German).

From KTG technical day on fuel element of the sodium-cooled breeder; Karlsruhe, F.R. Germany (28 Oct 1976).

In Fuel element of the LMFBR.

The creep-fracture behaviour of the irradiated material 1.4970 and possibilities to improve its behaviour are discussed. From this, it follows that the alloy 1.4970 ought to be strengthened more still with regard to creep rupture ductility and strength. The planned optimization programme considers the following parameter variations: 1. Solution heat temperature; 2. cooling rate; 3. thermo-mechanical treatment; 4. chemical modification (B, C, Ti).

10206 (KFK—2451) **Layout, design and post irradiation examination of Na-bonded fuel pins of the test group Mol 15.** Steiner, H.; Freund, D.; Jacobi, O.; Weimar, P. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). Apr 1977. 80p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

The experiment Mol 15 includes the irradiation of 4 fuel rod specimens with UC/PuC fuel (25 wt% Pu and Usub(nat)) of different M_2C_3 shares with Na bonding. It is the first capsule irradiation of Na-bonded carbide rods within the Project Fast Breeder. In the present report, design, irradiation, and post-irradiation examination of the fuel rods are described. At linear power ratings of maximum 1,150 W/cm and cladding temperatures of maximum 500°C burn-ups of nearly 9% fima were obtained without getting rod defects. Cladding deformations remained decidedly small (0.3% at the maximum). The cladding consisted of the material 1.4988(X8CrNiMoVNb1613). The fuel structure is caracterized by a highly porous zone in the interior followed by a narrow high-density zone. On three specimens, indications of a central cavity were found. Together with the anomalous bubble size, this suggests superheating of the after failure of the Na bonding during irradiation.

10207 (LA-UR—77-1956) **Surface area-burnoff correlation for the steam—graphite reaction.** Stark, W.A. Jr.; Malinauskas, A.P. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 14p. (CONF-770929—5). Dep. NTIS, PC A02/MF A01.

From Seminar on HTGR safety technology; Upton, New York, USA (15 Sep 1977).

The oxidation of core graphite by steam of air represents a problem area of significant concern in safety analyses for the high temperature gas cooled reactor (HTGR). Core and core-support graphite integrity and strength deteriorate with oxidation of the graphite, and oxidation furthermore could affect the rate of fission product release under upset conditions. Consequently, modeling of core response during steam or air ingress conditions requires an expression for the rate of graphite interaction with those impurities. The steam—graphite reaction in particular is a complex interaction of mass transport within the graphite with chemi-sorption and reaction on accessible surfaces; experimental results from graphite to graphite are highly variable, and the description of the reaction is not yet completely consistent. A simple etch pit model relating surface area to burnoff has been proposed and shown to provide reasonable correlation with experimental data obtained from steam oxidation studies of nuclear grade H-327 graphite. Unaccounted differences between theory and experiment arise at burnoffs exceeding 3 to 5 percent. The model, while not complete nor comprehensive, is consistent with experimental observations of graphite oxidation by O_2(air), CO_2, or H_2O, and could have some utility in safety analysis.

10208 (NEDM—14110) **Caustic stress corrosion tests for the LLTR.** Indig, M.E. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). May 1976. Contract EY-76-C-03-0893-010. 30p. Dep. NTIS, PC A03/MF A01.

A series of tests have been performed in order to determine the effects of the caustic resulting from the Na/H_2O reaction on the materials used in the LLTR-MSG series of testing. Stainless steel, 2 ¼ Cr—1 Mo and carbon steel have been evaluated. Stress corrosion cracking susceptibility and general corrosion are reported. Over the range of temperature, caustic concentration and heating rate tested the stainless steel stressed to 90% of yield or above suffered cracking. Whereas, the 2-¼ Cr—1 Mo and carbon steel were not cracked.

10209 (ORNL/TM—6081) **Inspection of boiler tubes: status and plans.** McClung, R.W. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 11p. .

Manufacturing examination and in-service inspection techniques are being developed for steam generators for the Breeder Reactor Program. The activities in the Breeder Reactor Program (BRP) to develop and apply techniques for both manufacturing and in-service inspection of sodium/water steam generators are summarized. The principal effort has been on the units for the Clinch River Breeder Reactor (CRBR).

10210 (TID—27817) **LLTR Series I test request. Revision 4. GE specification No. 22A3924, Rev. 4.** Regimbal, J.J. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Jun 1977. Contract EY-76-C-03-0893-010. 160p. .

Series I tests in the Large Leak Test Rig (LLTR) using the AI-MSG (modified for large-leak testing) are requested for the LLTR test facility currently being constructed at LMEC by Atomics International. The requested program of testing provides for water and/or steam to be injected into sodium under near prototype

conditions. Variables in the sodium/water reaction tests include leak size, steam generator type (evaporator or superheater) conditions, leak location, and sodium temperature. Test conditions and data acquisition requirements and methods are described in sufficient detail to serve as a basis for preparing the full scope of testing procedures necessary to accomplish the program objectives.

10211 (TID—27821) Vibration tests of a full scale water model of a Clinch River steam generator module. Durand, R.E.; Gabler, M.J.; Weinberg, L.; Yang, T.M. (Atomics International Div., Canoga Park, Calif. (USA); General Electric Co., Sunnyvale, Calif. (USA)). [nd]. Contract EY-76-C-15-2395. 17p. Dep. NTIS, PC A02/MF A01.

Cross and parallel flow induced vibrations were measured in a shortened full scale model of the CRBRP steam generators using water as the working fluid. M easurements were made on five selected tubes, some of which fit through oversize tube support holes. Power spectral density plots were made of vibration parameters at selected locations. Maximum displacement was about 3 mils and occurred at the lower frequencies. The maximum vibrational stress was calculated to be 2000 psi. Measurements of vortex shedding frequencies showed that vortices are not a dominant source of tube excitation. In general, no adverse effects on the CRPRP steam generators were identified which affect service life or structural integrity.

10212 Direct-coupled-ray method for design-oriented three-dimensional transport analysis. Bucholz, J.A. (Oak Ridge National Lab., TN); Poncelet, C.G. *Nucl. Sci. Eng.;* **64**: No. 2, 356-372(Oct 1977).

A fast three-dimensional design-oriented transport method has been developed for the solution of both neutron and gamma transport problems. It combines a nodal approach with analytic integral transport to achieve relative speed and accuracy. An analytic solution is obtained for the angular flux in each of the 14 directions defined by the six faces and eight corners of a cubic mesh block. The scheme used to accommodate high-order anisotropic scattering is based on the formulation of ray-to-ray scattering probabilities in an integral sense. A variable mesh approximation has also been introduced to provide greater flexibility. The details of a direct-coupled-ray (DCR) $\rightarrow P_1$ conversion technique have been developed but not yet implemented. The DCR method, as implemented in the TRANS3 code, has been used in a number of liquid-metal fast breeder reactor shielding applications. These included a one-dimensional deep penetration configuration and one-, two-, and three dimensional representations of the lower axial shield of the Clinch River Breeder Reactor. Comparisons with ANISN and DOT-III solutions indicated good to excellent agreement in most situations.

10213 Fast nuclear reactor. Kovin, V.M.; Mitenkov, F.M.; Ovechkin, A.V. US Patent 4,048,011. 13 Sep 1977. Filed date 13 Sep 1974. 6p.

The proposed fast nuclear reactor comprises a vessel, a liquid metal coolant filling said vessel, the side wall of which is cylindrical in shape and has its axis disposed in a horizontal plane. The vessel accommodates a core and heat exchangers with said liquid-metal coolant being passed therethrough by means of forced circulation thereof. The space above the coolant level is occupied by an inert gaseous medium, with the coolant contacting said medium in pipe branches penetrating the side wall of the vessel. 5 claims, 4 figures.

10214 Nuclear reactors. Durston, J.G.; Hind, J.R. (to United Kingdom Atomic Energy Authority). US Patent 4,046,629. 6 Sep 1977. Priority date 7 Jul 1975, United Kingdom of Great Britain and Northern Ireland (UK). 4p.

Thermal insulation for a core tank of a fast breeder nuclear reactor comprises a plurality of spaced membranes defining a series of concentric chambers lining the tank. Liquid metal is pumped from the cooler regions of a pool of coolant into the first chamber from which it flows successively through the remaining chambers towards the reactor core. 2 claims, 3 figures.

10215 Tasks of and methods for impurity control in sodium loops. Ullmann, H. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)). *Kernenergie;* **20**: No. 9, 269-274(Sep 1977). (In German).

The tasks of impurity control of sodium and inert gas in coolant circuits of sodium-cooled reactors are formulated. From this, the requirements to be met by the measuring methods are derived. The current status of the methods of measurement and analysis are evaluated. Fundamental directions of further development are discussed.

10216 (JAPFNR—264) FBR structural material test program. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Aug 1977. Translation of N—251-77-22. 39p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Work performed under United States—Japanese Fast Reactor Exchange Program.

In parallel with development of FBR, Power Reactor and Nuclear Fuel Development Corporation (PNC) has planned and carried out a series of structural material tests in order to establish the rational temperature designs for structural components. These material tests are partially conducted at the O-arai Engineering Center (PNC) but mostly undertaken at the plant fabricator, material manufacturers, academic societies and associations, national research institutes and universities at the request of PNC. Work to date and future plans are discussed.

10217 Method of detecting leakage of reactor core components of liquid metal cooled fast reactors. Holt, F.E.; Cash, R.J.; Schenter, R.E. (to Energy Research and Development Administration). US Patent 4,033,813. 5 Jul 1977. Filed date 22 Oct 1975. 4p.

PAT-APPL-624,804.

Disclosed is a method of detecting the failure of a sealed nonfueled core component of a liquid-metal cooled fast reactor having an inert cover gas. A gas mixture is incorporated in the component which includes Xenon-124; under neutron irradiation, Xenon-124 is converted to radioactive Xenon-125. The cover gas is scanned by a radiation detector. The occurrence of 188 Kev gamma radiation and/or other identifying gamma radiation-energy level indicates the presence of Xenon-125 and therefore leakage of a component. Similarly, Xe-126, which transmutes to Xe-127 and Kr-84, which produces Kr-85/sup m/ can be used for detection of leakage. Different components are charged with mixtures including different ratios of isotopes other than Xenon-124. On detection of the identifying radiation, the cover gas is subjected to mass spectroscopic analysis to locate the leaking component. 2 claims.

10218 Pump tank divider plate for sump suction sodium pumps. George, J.A.; Nixon, D.R. (to Energy Research and Development Administration). US Patent 4,029,123. 14 Jun 1977. Filed date 20 Aug 1975. 6p.

PAT-APPL-606,043.

A circular plate extends across the diameter of a sump suction pump, with a close clearance between the edge of the plate and the wall of the pump tank. The plate is located above the pump impeller, inlet and outlet flow nozzles but below the sodium free surface and effectively divides the pump tank into two separate chambers. On change of pump speed, the close fitting flow restriction plate limits the rate of flow into or out of the upper chamber, thereby minimizing the rate of level change in the tank and permitting time for the pump cover gas pressure to be varied to maintain an essentially constant level. 4 claims, 3 figures.

10219 Turbulent convective heat transfer from rough surfaces with two-dimensional rectangular ribs. Dalle Donne, M.; Meyer, L. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (Germany, F.R.)). *Int. J. Heat Mass Transfer;* **20**: No. 6, 583-620(Jun 1977).

Artificial roughness is often used in nuclear reactors to improve the thermal performance of the fuel elements. Although these are made up of clusters of rods, the experiments to measure the heat-transfer and friction coefficients of roughnesses are performed with single rods contained in smooth tubes. A new transformation method to obtain data applicable to reactor fuel elements from these annulus experiments is illustrated. New experimental friction data are presented for ten rods, each with a different artificial roughness made up of two-dimensional rectangular ribs. For each rod four tests were performed, each in a different outer smooth tube. For two of these rods, each for two different outer tubes, heat-transfer data are also given. The friction and heat-transfer data, transformed with the present method, are correlated by simple equations. These equations are applied to a case typical for a Gas Cooled Fast Reactor fuel element.

10220 Energy gap and the fast reactor. Hill, J. (UKAEA). *Atom (London);* No. 248, 106-109(Jun 1977).

The author discusses the case for nuclear energy and in particular for the fast reactor. The real limitations to the fast reactor system are considered from the viewpoints of physics, sodium coolant, fuel, and engineering.

10221 Liquid-metal dip seal with pneumatic spring. Poindexter, A.M. (to Energy Research and Development Administration). US Patent 4,026,763. 31 May 1977. Filed date 12 Apr 1976. 4p.

PAT-APPL-675,845.

An improved liquid-metal dip seal for sealing the annulus between rotating plugs in the reactor vessel head of a liquid-metal fast-breeder nuclear reactor has two legs of differing widths communicating under a seal blade; the wide leg is also in communication with cover gas of the reactor and the narrow leg is also in communication with an isolated plug annulus above the seal. The annulus contains inert gas which acts as a pneumatic spring. Upon increasing cover gas pressure which depresses the level in the wide leg and greatly increases the level in the narrow leg, the pneumatic spring is compressed, and resists further level changes, thus preventing radioactive cover gas from bubbling through the seal.

10222 Superphenix. A breeder reactor in full scale. Lingjaerde, R. (Institutt for Atomenergi, Kjeller (Norway)); Vendryes, G.A. *Tek. Ukebl.;* **124**: No. 22, 12,14,16(20 May 1977). (In Norwegian).

A description of the Super Phenix reactor is preceeded by a brief discussion of the background for the development of the breeder reactor and of the basic principles of the fast breeder. In conclusion the time schedule for Super Phenix is presented and the future prospects for fast breeder nuclear power plants in France are briefly discussed.

10223 Improved nuclear fuel assembly grid spacer. Marshall, J.; Kaplan, S. (to Energy Research and Development Administration). US Patent 4,021,300. 3 May 1977. Filed date 23 May 1975. 10p. PAT-APPL-580,498.

Disclosed is an improved fuel assembly grid spacer and method of retaining the basic fuel rod support elements in position within the fuel assembly containment channel. The improvement involves attachment of the grids to the hexagonal channel and forming the basic fuel rod support element into a grid structure, which provides a design which is insensitive to potential channel distortion (ballooning) at high fluence levels. In addition the improved method eliminates problems associated with component fabrication and assembly.

10224 Gas-cooled fast breeder reactors. Chermanne, J. (Societe Belge pour l'Industrie Nucleaire, Brussels). *Phys. Technol.;* **8**: No. 3, 89-93(May 1977).

Assuming that, in spite of the problems related to its safety, nuclear energy will be the one on which society will rely most heavily for its economy and prosperity, the need for fast breeder reactors is becoming urgent as uranium becomes increasingly difficult and expensive to obtain. Designs for a gas-cooled breeder reactor (GBR) appear to offer distinct advantages over liquid-metal-cooled types and much of the technology is already familiar. The safety, economic and performance aspects of the GBR are discussed.

10225 Structural analysis technology for high-temperature design. Greenstreet, W.L. (Oak Ridge National Lab., Tenn. (USA)). *Nucl. Eng. Des.;* **24**: No. 3, 375-386(May 1977).

Results from an ongoing program devoted to the development of verified high-temperature structural design technology applicable to nuclear reactor systems are described. The major aspects addressed by the program are (1) deformation behavior; (2) failure associated with creep rupture, brittle fracture, fatigue, creep-fatigue interactions, and crack propagation; and (3) the establishment of appropriate design criteria. This paper discusses information developed in the deformation behavior category. The material considered is type 304 stainless steel, and the temperatures range to 1100°F (593°C). In essence, the paper considers the ingredients necessary for predicting relatively high-temperature inelastic deformation behavior of engineering structures under time-varying temperature and load conditions and gives some examples. These examples illustrate the utility and acceptability of the computational methods identified and developed for prediting essential features of complex inelastic behaviors. Conditions and responses that can be encountered under nuclear reactor service conditions and invoked in the examples.

10226 Recent developments in equipment for sodium test loops and fast reactors. Orszak, P. *Nucl. Eng. Int.;* **22**: No. 257, 53-55(May 1977).

Since completion of PFR, work of GEC Reactor Equipment Ltd. on sodium has developed further and a standard range of sodium components is being marketed. These include level monitoring equipment, flow-meters, a wide range of electro-magnetic pumps, automatic plugging meters, cleanup units, filters, pressure vessels and valves. In order to test and prove these products the Company has established its own sodium test facility. Special test loops have been constructed to establish the performance, durability and reliability of components and for equipment calibration.

10227 Careful attention to detail was necessary in developing the SuperPhenix steam generators. Robin, M.G. *Nucl. Eng. Int.;* **22**: No. 257, 46-48(May 1977).

The development, design, and testing of the SuperPhenix steam generator are described. The generator is a once-through unit with economizer, evaporator, and superheater located along the same tube. Its features are illustrated, including the method of tube fastening an spacing. The material for the generator is 316 L stainless steel, and the tube bundle material Alloy 800. Development tests were conducted to investigate thermal and flow performance, tube penetrations under thermal shock, fatigue and wear of expansion bends, sodium flow and tube vibration, and safety in case of steam tube failure.

10228 Operation of Protype Fast Reactor steam generators led directly to commercial-size design. Taylor, D. *Nucl. Eng. Int.;* **22**: No. 257, 49-53(May 1977).

The design and manufacture of the PFR steam generators are outlined. Experiences with leaks in evaporators and superheaters during operation are described. These have led to certain design changes for the steam generators for the commercial demonstration fast reactor, which are discussed. The main changes are: adoption of ferritic steel in place of austenitic to avoid stress corrosion and caustic cracking after a leak; elimination of welded joints to simplify manufacture and minimise the chance of leaks; redesign of the header system to eliminate thick tube plates and thermal shock problems. These changes can be accommodated in the 'U' tube type of generator but in place of the forced circulation system adopted for PFR a 'U' tube partial recirculation boiler with separate evaporator and superheated is proposed for the commercial fast reactor.

10229 SIMPLE-2: a computer code for calculation of steady-state thermal behavior of rod bundles with flow sweeping. Jones, O.C. Jr.; Yao, S.C.; Henry, R.E. (Argonne National Lab., Ill. (USA)). *Nucl. Eng. Des.;* **41**: No. 2, 205-217(Apr 1977).

A computer code has been developed for use in making single-phase thermal hydraulic calculations in rod bundle arrays with flow sweeping due to spiral wraps as the predominant crossflow mixing effect. This code, called SIMPLE-2, makes the assumption that the axial pressure gradient is identical for each subchannel over a given axial increment, and is unique in that no empirical coefficients must be specified for its use. Results from this code have been favorably compared with experimental data for both uniform and highly nonuniform power distributions. Typical calculations for various bundle sizes applicable to the LMFBR program are also included.

10230 Method for heat exchanger leak detection in a liquid metal cooled nuclear reactor. Sayre, R.K. (to Westinghouse Electric Corp.). US Patent T955,004. 1 Feb 1977. Filed date 5 Apr 1976. 2p.

An on-line method is described for early detection of a leak through a tube of a liquid metal-to-water tube type heat exchanger in a liquid metal cooled nuclear reactor system. Introducing helium to the heat exchanger feedwater exposes the helium to any heat exchanger leak locations, and the helium will diffuse or flow through the leak location into the liquid metal. An increase in the helium content of the liquid metal evidences the existence of a leak. The content of helium in the liquid metal can be detected either by direct analysis of the reactor cover gas in a dual cycle reactor plant, or by removing a coolant sample from the reactor system downstream of the heat exchanger in a dual or triple cycle plant, separating the gaseous content of the sample, and analyzing the gaseous content for helium. The properties of helium are such that the invention method may result in identification of a tube leak before any water and liquid metal actually come in contact.

10231 (EURFNR—1447) Heating rods for simulation of fuel pins in liquid metal boiling experiments. Part I. Casal, V.; Demski, A.; Graf, E.; Hartmann, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorbauelemente). Jan 1977. Translation of KFK—2368. 48p. Dep. NTIS, PC A03/MF A01.

Work performed under United States—Euratom Fast Reactor Exchange Program.

This report describes the design, development and testing of electrical heater rods for boiling tests in LMFBR fuel element simulators. The tests are required as a proof of the capability to control local and gross boiling in the core of SNR-300. The setup and performance of the tests call for heater rods simulating with a very high operating reliability the assumed incidents of SNR-300, even under transient conditions. Loads of the heating surface of up to 170 W/cm² must be attained at coolant temperatures of 950°C. The concept selected for the heater rod is an improvement of heater rods used in single-phase heat transfer tests. The heat is generated in the heater rod by ohmic heating of a tape helix. The heat passes the insulator, a layer made of compacted boron nitride powder, and reaches the cladding of the heater rod. The current conductor is made of a nickel-chromium alloy while the cladding material is stainless steel. The concept of the heater rod and the fabrication method have proved to be good. For instance, rejections in the fabrication process, including the instrumentation, are less than 1 percent. In the boiling experiments performed on two 7-rod bundles and one 169-rod bundle containing 88 heated rods no heater rod has failed so far.

10232 γ-ray heating in a 300-MW(e) gas-cooled breeder reactor. Razani, A.; Nagel, M.; Rouse, C.A.; Perkins, R.G.; Cerbone, R.J. (General Atomic Co., San Diego, Calif. (USA)). *Ann. Nucl. Energy;* **4**: No. 2, . 51-58(1977).

Distributed source and neutron coupled γ-ray methods were used to evaluate γ-ray heating rates in the core and blanket of the Gas Cooled Fast Breeder Reactor. ENDF/B-IV, nuclear data files were used. Contributions of secondary γ-rays (n,γ) and (n,xγ), fission product decay γ-rays, and breeding product decay γ-rays to γ-ray heating rates were calculated. Transport of γ-rays produced in the core was found to dominate the blanket γ-ray heating near the core/blanket interface, decreasing significantly at points far away from interface. Near the center of the radial blanket decay γ-rays

from the breeding products were found to be the major contributor of heat.

10233 Association of breeder and converter reactors. A general picture. Fortescue, P. *Ann. Nucl. Energy;* **4**: No. 2, . 59-63(1977).

Consideration is given to the use of diverse reactor types to secure total natural fuel utilization for an expanding industry. Characteristics of a breeder-converter association are examined. An important characteristic is the relation between the ratio of their installed powers and the resulting annual fraction growth this can sustain using only naturally occurring fuels. Appropriate approximations are derived and their implications illustrated graphically. It is concluded that a high breeding gain is highly desirable to exploit the benefit from a breeder-converter association and in breeders built for the purpose it should be devoted initially to ^{233}U rather than Pu production. The introduction of the breeder-converter association should be phased from first a rapid industry expansion where LWRs provide the Pu for the breeder inventories, following by a more relaxed expansion using HTRs initially fuelled by ^{235}U, and finally ^{233}U inventories for HTGRs. The breeder-converter association since it utilizes Th as well as U and encourages a higher conversion, enables the ideal of near total use of all fertile material to be reached more completely and rapidly.

10234 (EURFNR—1404) Considerations for the future development of shell- and core-structural materials for fast breeders. Anderko, K.; Wassilew, C. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). Nov 1976. Translation of KFK—2369. 33p. Dep. NTIS, PC A03/MF A01.

Work performed under United States—Euratom Fast Reactor Exchange Program.

The report gives (1) a survey on the projected or already progressing development work for the improvement of shell and core structural materials for Fast Breeder Reactors in the Debene countries, and (2) a detailed discussion of one of the property aspects, the creep strength depending on time. After a look at the creep rupture behavior of irradiated materials and at the role played by inter- and intragranular precipitations, and optimization program for the austenitic alloy X10 NiCrMoTiB 15 15 (1.4970) is outlined. The published data on the residual ductility after high neutron doses at short-term and creep loadings are reviewed.

10235 Development of sodium penetration equipment. Nihei, T.; Miyazawa, T. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). *Doryokuro Giho;* No. 20, 37-49(Oct 1976). (In Japanese).

In the development of sodium-cooled fast breeder reactors, various measuring and monitoring methods are required for securing the safety and improving the operational rate, which have never been seen in conventional reactors. One of them is the requirement to monitor optically the state of the structures within a reactor as opaque liquid sodium is filled in it. The sodium penetration equipment, which scans with ultrasonic beam, monitors its reflecting or penetrating waves, and makes images, is promising. The development is carried out mainly by the Power Reactor and Nuclear Fuel Development Corporation in Japan. The main functions are the observation and identification of fuel assemblies, the observation of other structural changes, and the confirmation of the state of control rods. FFTF system in the U.S., Phenix system in France, the system for CFR in U.K., A-scope system in FRG, and PNC system in Japan are briefly explained. The sodium-penetrating equipment manufactured for trial comprises a supersonic transducer, transducer-driving mechanism, and display portion. The horizontally sodium-penetrating equipment is intended for confirming the gap between the core and the core upper mechanism, and it comprises also a supersonic transducer, transducer-driving mechanism, a reflecting plate and display portion. The basic test was carried out in water with reduced scale model, and the S/N ratio, the accuracy of fixing the reflecting plate, the limit of detecting the gap, the horizontal resolution, and mutual interference were examined.

10236 Development of LWBR in USA. Synek, S. *Jad. Energ.;* **22**: No. 9, 355-358(Sep 1976). (In Czech).

The results are briefly assessed of the research of the light-water breeder reactor and the basic requirements on its design are given. The current development programme of the light-water breeder reactor in the US is described. The parameters are given of a reactor for uranium 233 production (1000 MWe) currently projected and of a light-water breeder reactor (1000 MWe).

10237 Development of cold traps. Mochizuki, K.; Nagase, N. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). *Doryokuro Giho;* No. 19, 37-45(Jul 1976). (In Japanese).

Cold traps for liquid sodium coolant systems are described. Three basic designs of cold traps used at Oarai Engineering of Power Reactor and Nuclear Fuel Development Corp. are shown. Impurities are trapped by the cold traps at the entrance and exit of the mesh portion. The concentration of oxygen in liquid sodium depends on temperature. The operation temperature of cold traps for the experimental reactor Joyo is set at 150 degree C. In the secondary cooling system, hydrogen concentration is more important, and the temperature is decided by this concentration. It is necessary for designing a fast reactor to estimate the amount of impurities accumulating during its life time. In a primary cooling system, oxygen in purchased sodium, initially residual oxygen in the system, oxygen adsorbed on the surfaces of structural materials, oxygen brought in with fuel, oxygen transferred from cover gas and seal gas, and oxygen entering at the time of maintenance are considered. In a secondary system, Oxygen and hydrogen must be taken into account. Efficiency of trapping and the amount of trapped oxygen are described. Further improvement of cold traps is continued.

10238 Method for correction of fast system macroscopic constants using single experiment results. Vasil'ev, Y.Y.; Gurin, V.N.; Dubovskii, B.G. *At. Energ. (USSR);* **40**: No. 3, 242(Mar 1976). (In Russian).

Deposited article; for English translation see the journal Sov. J. At. Energy.

10239 Construction materials behaviour in the N_2O_4 dissociating coolant and NPP safety problems. Fedyushin, E.E.; Gol'tsev, V.P. (AN Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 3, 69-72(1976). (In Russian).

Some aspects of a safety problem of gas-cooled nuclear reactors using the N_2O_4 dissociating system as a coolant are considered. The investigations deal with corrosive behaviour of construction materials in this coolant. Stainless chromium-, chromium and nickel alloyed austenitic steels and a number of other materials are shown to possess a high corrosive resistance (approximately0.001-0.03 mm/year) in the N_2O_4-coolant at high temperatures and pressures under reactor irradiation and may be successfully used for the construction of elements and units of the NPP in question. In particular, steel of the Kh16N15M3B type, as to the whole complex of its properties, is considered one of the most promising materials used for fuel elements coatings in reactors with the dissociating coolant. Behaviour of non-metallic materials in the N_2O_4 medium and in the gaseous atmosphere of its vapours is considered as a possible case of production of explosive compounds when some materials come into contact with N_2O_4.

10240 Dynamics of power plants with the dissociating coolant. Sharovarov, G.A. (AN Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 3, 14-18(1976). (In Russian).

Dynamic features of plants with the nitrogen tetroxide dissociating coolant are considered. Analysis of the coolant as a dynamic system is given. Dynamics of plants of this type substantially differs from that of steam-water and gas-turbine plants. Turbines with the dissociating working substance are substantially smaller than those working on water vapor at equal capacities. This results in decreasing an inertia moment of a turbine rotor and a time constant of a turbo-generator, correspondingly. The times of transients in separate plant units are different. They proceed faster in fuel elements and turbo-generators and more slowly- in a condensator. Comparably short times of transients in a turbogenerator and single-circuit of a plant are responsible for reactor sensitivity to the perturbations caused by turbo-generator dynamics. To maintain thermal conditions in a reactor at rapid drops of load, it is proposed that the control system of coolant pressure and temperature be used outside the reactor. The bypass valve is an actuating mechanism of the system. The performed investigations show that a wide region of possible change of parameters is provided over the whole range of operating conditions, which offers favourable prerequisites for reliable operation in variable and transient states.

10241 Efficiency of filtering elements and their regeneration in the N_2O_4 medium. Atroshenko, E.I.; Bida, L.A.; Klimko, O.G.; Neshkov, P.F.; Romanov, V.M. (AN Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 4, 75-80(1976). (In Russian).

Filtering elements of stainless steel powder were investigated. In addition, an element of stainless steel net wasinvestigated. The work was aimed at the definition of purification efficiency of the N_2O_4-coolant when plant is working in a closed gas-liquid cycle, filtration duration and the possibility of multiple reduction of filtering elements by various types of regeneration. The investigations were carried out at the experimental plant comprising a capacity with the coolant, a circulating pump, a filter, a once-through evaporator and an overheater, a condenser, auxiliary equipment and monitoring instruments. The plant operated in a liquid and a gas-liquid cycle. As a result of investigations carried out it was stated, that filtering barriers of stainless steel powder and stainless net filter the N_2O_4-coolant sufficiently well when the plant operates in a gas-liquid cycle. Besides, they are quickly reduced by various types of regeneration (impulse rinsing by the liquid coolant, blowing by the

coolant vapour). The results of the work performed may be used in nuclear power engineering when applying N_2O_4 as a coolant and a working substance.

10242 Radiological significance of transuranium radioisotopes released to the environment during operation of the LMFBR fuel cycle. Barr, N.F. (Energy Research and Development Administration, Washington, D.C. (USA)). pp 649-655 of In Transuranium nuclides in the environment. Vienna; IAEA (1976).

From Symposium on transuranium nuclides in the environment; San Francisco, Calif., USA (17 - 21 Nov 1975).

Estimates based on current knowledge and conservative assumptions indicate that release of transuranium elements from the Liquid Metal Fast Breeder Reactor (LMFBR) fuel cycle are likely to proaduce population dose commitments small compared to those produced by naturally occurring alpha emitters and globally dispersed transuranium radioisotopes from tests of nuclear weapons in the atmosphere. Potential health consequences of these releases to current and future generations are estimated to be very small compared to risks associated with the production of energy by fossil fuels. The estimates are subject to a number of uncertainties imposed by lack of knowledge. Some of the uncertainties are not likely to be greatly reduced until LMFBR facilities are designed and operated. Others may be significantly reduced prior to facility design and operation. The paper discusses the sensitivity of the estimates to uncertainties and approches to reducing those uncertainties that strongly influence the estimates.

10243 Some considerations on fast breeder reactor penetration in Italy. Baldo, L.; Viotti, V. (Progettazioni Meccaniche Nucleari, Genoa (Italy)); Lanz, R.; Musso, B. (Nucleare Italiana Reattori Avanzati (NIRA) Genova, Italy). *Energ. Nucl. (Milan);* **23**: No. 8, . 423-236(1976). (In Italian).

This paper deals with the possible role of liquid metal fast breeder reactors (LMFBR) in the Italian electric power system, in an optimized utilisation strategy of natural nuclear fuel resources. The effects on fast breeder reactor penetration of possible alternative policies of light-water and heavy-water nuclear plants installation are studied. Core design and fuel cycle parameters, limiting LMFBR maximum penetration in supplying a large portion of primary energy needs of the country, are also discussed.

10244 Device for protecting deformations of reactor cores. Kato, Y.; Urushihara, H. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-148198/A/. 13 Jun 1975. 5p. (In Japanese).

The object of the invention is to provide a fluid pressure cylinder which is operated according to change in temperature of coolant for a reactor to restrain or release a core, to simply and effectively protect deformation of the core. A closed fluid pressure cylinder interiorly filled with suitable fluid is disposed in peripherally equally spaced relation in an annular space between a core barrel of a reactor and a reactor vessel. A piston is mounted in fluid-tight fashion in a plurality of piston openings made in the cylinder, the piston being slidably moved according to expansion and contraction of the fluid filled in the cylinder. The piston has a movable frame mounted at the foremost end thereof, the movable frame being moved integral with the piston, and the surface opposite the mount thereof biasing the outermost peripheral surface of the core.

10245 Primary cooling device for a sodium cooled fast breeder. Kawashima, H. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-148199/A/. 13 Jun 1975. 4p. (In Japanese).

The object of the invention is to positively position a return pipe nozzle for leaked sodium in pump to a given depth below sodium level thereby eliminating possible entry of gas and the provision of a pump overflow column. In a primary cooling device for a sodium cooled fast breeder comprising a reactor vessel, an intermediate heat exchanger, a cold leg mechanical circulating pump, a pipe for leaked sodium in pump, and a guard vessel, a return pipe is provided to directly return leaked sodium in the circulating pump to a medium pressure and low temperature portion of the reactor vessel. Since the returning destination of the return pipe for leaked sodium in the pump is within the reactor vessel, the liquid level of the circulating pump is positively maintained above the liquid level of the reactor vessel so that the return pipe nozzle for leaked sodium in pump is positively positioned to a given depth below sodium level.

10246 Method for draining liquid metal. Yokota, N.; Naito, K.; Ozawa, Y.; Minato, A.; Fukushima, Y. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-137088/A/. 23 May 1975. 7p. (In Japanese).

The object of the invention is to connect a pit chamber, a primary cooling system piping and a machine room to a damp tank through a drain passage thereby recovering leaked liquid metal to prevent the surrounding atmosphere from being contaminated. The pit chamber, primary cooling system piping and primary cooling system machine room are connected to a damp tank through a drain passage. A plug made of metal (such as lead, tin, etc.) having a low melting point is mounted at a connection between the aforementioned chambers and the drain passage. When high temperature liquid metal (Na, K, Li, etc.) are stayed on the plug, the plug is fused by heat to open the passage. Also, a gas take-out passage for allowing vapor from the damp tank to be escaped is disposed around the drain passage so that fluid flowing through the drain passage and fluid flowing through the gas take-out passage may be heat-exchanged. The materials suspended in the gases may be removed by a vapor trap or the like.

10247 Fast breeder reactor. Ito, S.; Maki, K. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-124789/A/. 23 Apr 1975. 3p. (In Japanese).

The object of the invention is to conserve loaded fuel, aquire controllable surplus reaction degree, increase the breeding index, flatten output and improve sealing of neutrons by inserting a decelerating substance in a blanket section. A decelerating substance such as beryllium or beryllium oxide is inserted in a blanket section between an outer reactor core and reflector. With this arrangement, neutrons are decelerated to increase the low energy components, which are partly subjected to reflection by the outer reactor core to thereby reduce leakage of neutrons from the reactor core.

10248 Method of controlled maintenance of reactor. Orii, S.c; Yoshizawa, K. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-124792/A/. 22 Apr 1975. 3p. (In Japanese).

A method is disclosed to improve the operability of maintenance of a reactor at the time of function of a seal section for sealing radioactive material by employing a filler pouring method. Structure: When a rupture takes place in a seal bellows provided in a high-speed breeder reactor control rod drive mechanism upper guide duct, a sealing compound is poured from a back-up seal gas inlet hole formed in a control rod drive mechanism housing mounted on a lift rod mechanism and agglomerated to seal the upper portion of the guide duct so as to maintain gas-tightness on the inside, thereby preventing loss of reactor cover gas due to leakage.

10249 Liquid level control system of fast reactor secondary cooling system. Mori, K.; Matsumoto, K. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-113094/A/. 31 Mar 1975. 8p. (In Japanese).

A system is disclosed whose object is too minimize the range of the liquid level variation of the cooling system and reduce the time required for the liquid level control by sealing the gas of a cover gas respiration system which acts upon an evaporator and pump overflow column. In liquid level control by the cover gas pressure of a high-speed reactor secondary cooling system, upon occurrence of a sudden change in the rate of flow of the recirculated liquid, automatic check valves provided in an evaporator and pump overflow column cover gas respiration system are completely or substantially closed, while at the same time the recirculation cooling medium is sucked up and an automatic check valve provided in the overflow system is closed.

10250 Atomic power plant. Kawakami, H. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-113096/A/. 31 Mar 1975. 6p. (In Japanese).

The object of the invention is to permit decay heat to be reliably removed after reactor shut-down at such instance as occurrence of loss of power by means of an emergency water supply pump. An atomic power plant has a closed cycle constructed by connecting a vapor generator, a vapor valve, a turbine having a generator, a condenser, and a water supply pump in the mentioned order, and is provided with an emergency water supply pump operated when there is a loss of power to the water supply pump, a degasifier pressure holding means for holding the pressure of the degasifier by introducing part of the vapor produced from said vapor generator, and a valve for discharge to atmosphere provided on the downstream side of said vapor generator.

10251 Door valve. Honda, N.; Sakaguchi, S.; Goto, T.; Horikawa, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-110194/A/. 24 Mar 1975. 3p. (In Japanese).

Leakage of inner fluid in a door valve is blocked by providing a bellows mechanism in a portion where a valve rod penetrates an oil hydraulic cylinder and by sealing opposite side valve seats of the valve body with an oil hydraulic type seal mechanism. A door valve comprising a valve body movably provided within a valve casing, an oil hydraulic mechanism driving a valve rod directly connected to the valve body, a bellows mechanism provided on a portion where a valve rod penetrates the cylinder of the oil hydraulic mechanism and an oil hydraulic seal mechanism provided on the inner side of an inlet of the valve casing opposing a valve seat of the valve body, thereby isolating such components as the reactor container, casker, relay container and fuel storage tank at the time of replacement of fuel and reliably preventing leakage of liquid metal vapor containing radioactive material.

10252 Rotary plug. Orii, S.; Fujiki, K. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-108194/A/. 19 Mar 1975. 3p. (In Japanese).

A rotary plug is provided for a reactor comprising a large disc and a small disc disposed eccentrically thereto and rotatably using liquid metal as the coolant, the large and small discs having sliding surfaces formed with stepped portions in which a resilient member is interposed, thus minimizing the amount of solidified and deposited Na steam to effect smooth rotation. A V-shaped annular spring having a surface hardened layer placed in intimate contact with a large rotary plug and a small rotary plug is provided to block, during the operation of the reactor, upward movement of Na steam which is produced from Na liquid surface and tends to be moved up after entry into an annular space, and to, when the furnace is stopped in operation to rotate the rotary plugs, minimize a shearing stress created when the small rotary plug is lifted and to minimize a reverse rotational torque created when the large and small rotary plugs are rotated relative to eath other.

10253 Safety valve system foı a nuclear vessel cover gas. Itami, K. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-104190/A/. 12 Mar 1975. 4p. (In Japanese).

Leakage of a radioactive gas from a valve seat is presented by providing a burst plate downstream of a pressure relief valve. A pressure relief valve is disposed at the side of a nuclear reactor. A first burst plate is provided at an outlet opening in the valve in order to prevent the leakage of a radioactive gas. A compression system is provided to break the burst plate. A second burst plate is provided in the compression system thereby to being the pressure in the space surrounded by the pressure relief valve and the first and second burst plates into equality with the pressure of the ambient atmosphere.

10254 Fuel assembly for a nuclear reactor. Takeda, S.; Sakagami, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-104186/A/. 10 Mar 1975. 2p. (In Japanese).

To prevent the heat-induced bending of a fuel assembly for use in a fast breeder reactor due to a thermal difference radially of the fuel assembly within the reactor core. A wrapper tube is provided which has a corrugated or wavy wall portion on a higher output (or higher temperature) side of a reactor core thereby to absorb the elongation of the wall of the tube on the higher temperature side and to prevent the bending of the tube.

10255 Failed fuel detector for nuclear reactors. Takahara, K. (to Hitachi·Ltd., Tokyo (Japan)). Japanese Patent 1976-101693/A/. 4 Mar 1975. 4p. (In Japanese).

Cover gas is circulated by the suction of an ejector utilizing the potential energy of overflow sodium, thereby dispensing with power for cover gas circulation. Using the suction provided by the ejector the cover gas within the reactor container is withdrawn successively through a duct, vapor trap, failed fuel detector, and another duct. It is then mixed with sodium flowing through the overflow duct, and the mixture is led to an overflow tank for separation of gas and liquid. Next, the gas is returned to the reactor container through a duct, cover gas header and another duct.

10256 Rotary shield plug. Maruya, K.; Okuma, T. (to Mitsubishi Atomic Power Industries, Inc., Tokyo (Japan)). Japanese Patent 1976-92994/A/. 12 Feb 1975. 4p. (In Japanese).

A device to shield Na vapor of a liquid metal coolant accommodated within the container of a fast reactor with a doublewall shield structure, thereby increasing the shielding reliability is described. A gap between the container wall of fast reactor container and rotary plug for closing the top opening of the reactor container is hermetically shielded at the upper end and is doubly shielded at the lower end by two shielding means. Of these shielding means, the first one projects from the container wall and is in contact with the bottom of the rotary plug, while the second shield means consists of a first annular member extending from the bottom of the rotary plug and a second annular member extending from the container wall and abutting the first annular member to define a space between the first and second annular members. Further, an inert gas circulating means is provided between a blow-in inlet positioned above the first shield means on the container wall and an exhaust outlet positioned above the space within the container wall.

10257 Apparatus for controlling molten core debris. Golden, M.P.; Tilbrook, R.W.; Heylmun, N.F. (to Energy Research and Development Administration). US Patent 4,036,688. 19 Jul 1972. Filed date 9 Apr 1975. 16p.

PAT-APPL-566,489.

Disclosed is an apparatus for containing, cooling, diluting, dispersing and maintaining subcritical the molten core debris assumed to melt through the bottom of a nuclear reactor pressure vessel in the unlikely event of a core meltdown. The apparatus is basically a sacrificial bed system which includes an inverted conical funnel, a core debris receptacle including a spherical dome, a spherically layered bed of primarily magnesia bricks, a cooling system of zig-zag piping in graphite blocks about and below the bed and a cylindrical liner surrounding the graphite blocks including a steel shell surrounded by firebrick. Tantalum absorber rods are used in the receptacle and bed. 9 claims, 22 figures.

10258 Transit device for reactor fueling. Saijo, T.; Hayashi, H.; Yamaki, H.; Sasaki, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-110195/A/. 10 Dec 1971. 3p. (In Japanese).

The object of the invention is to effect refueling without detracting from the safety of the nuclear container by providing a relay container which has two openings for communication with the inside and outside of the container and is also provided with cooling and heating means, a chain being provided with a bucket disposed for revolution between the inlet and outlet. A relay container filled with an inert gas and a nuclear container are connected together with a first fuel inlet and outlet passage provided with a door valve, and the relay container and outside of the nuclear container are connected together with a second fuel inlet and outlet passage having a door valve. Further, a transfer means including a fuel container capable of movement between both the passages is provided.

REGULATION AND LICENSING

REFER ALSO TO CITATION(S) 10485

10259 (NUREG—0302(Rev.1)) **Remarks presented (questions/answers discussed) at public regional meetings to discuss regulations (10 CFR Part 21) for reporting of defects and noncompliance, July 12—26, 1977.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Inspection and Enforcement). Sep 1977. vp. NTIS $8.00.

In enacting the Energy Reorganization Act of 1974, Congress included Section 206 which requires the reporting of defects and noncompliances directly to the Nuclear Regulatory Commission (NRC). This congressional action required that the NRC promulgate rules and regulations, as necessary, to assure appropriate implementation of Section 206. In response to this mandate, the NRC drafted a new regulation. Following a period of public comment and revision, the regulation identified as 10 CFR Part 21, Reporting Defects and Noncompliance, was published in a Federal Register Notice on June 6, 1977. To assist NRC licensees and other firms and organizations covered by the new Part 21 regulation, public regional meetings were conducted by staff representatives to explain the rule. At these meetings the staff presented prepared remarks and answered questions on the meaning and application of the rule. Staff remarks contained in the original publication of this document were also provided to those in attendance. At each meeting the staff received a request for the questions and answers discussed by the staff to be made available for use as guidance by the nuclear industry covered by the rule. It was announced that a consolidation of the staff position question/answer guidance would be made available to each organization or firm attending these meetings and for others where a request is made in accordance with the directions printed insidethe front cover of the document. The staff will be guided in its implementation and enforcement of Part 21 by the positions set forth in the document. The revision of NUREG-0302 includes the following three parts relating to 10 CFR Part 21: (1) remarks presented by staff representatives; (2) Federal Register Notice material; and (3) a consolidation of questions and answers from the public regional meetings.

10260 (RDT-F—1-3T(9-77)) **Preparation of unusual occurrence report.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Reactor Development and Demonstration). Sep 1977. Contract W-7405-ENG-26. 18p. .

This standard contains the requirements for reporting unusual occurrences and the instructions for preparing unusual occurrence reports (UORs), including their organization, content, format, distribution, and periodic status reporting.

10261 (RDT-F—3-10T(8-77)) **Nondestructive examination of reactor core components.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Reactor Development and Demonstration). Aug 1977. Contract EY-76-C-14-2170. 37p. .

This standard establishes requirements applicable to the nondestructive examination of replaceable reactor core components. Core components consist of the fuel rod, control rod, and radial reflector assemblies and their subcomponents.

10262 Problems in the utilization of nuclear power. Heitzer, H. (Bayernwerk A.G., Muenchen (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **22**: No. 6, 343-346(Jun 1977). (In German).

A survey of the power supply situation in the FRG indicates that the use of nuclear power is necessary now and at least on a medium term basis. However, this has created some problems, a few important and topical ones of which are discussed. They are also related to the planned 5th Amendment of the Atomic Energy Act.

The report in particular refers to the measures proposed to streamline the licensing procedure, the problems associated with the determination of sites for nuclear power stations, the immediate execution of construction permits, the waste management of nuclear power stations, and the future development of atomic law.

10263 Prelimary injunction against nuclear power plant opponent. *Energiewirtsch. Tagesfragen;* **27**: No. 5, 381-383(May 1977). (In German).

The regional court at Hamburg, with its judgment of February 18th, 1977 - 74 0 43/77 - has confirmed a preliminary injunction which had been procured by two enterprises engaged in the erection of the Kernkraftwerk Brokdorf against a teacher in physics from Hamburg. On account of the preliminary injunction of February 15th, 1977, it was forbidden for the respondent, under threat of penalty or detention, to 1) call for the occupation of the site of the planned Kernkraftwerk Brokdorf, consisting of plots..., in particular of the area... surrounded by the fence, 2) participate in actions concerned with the occupation of the site mentioned, in particular to trespass this site and to support actions of this kind. The respondent had raised objection against this preliminary injunction. The main reasons upon which the judgment is based are given in full.

10264 Petitions to put a stop to building concerning the Kernkraftwerk Grohnde rejected. *Energiewirtsch. Tagesfragen;* **27**: No. 4, 310-312(Apr 1977). (In German).

The Administrative Court at Hannover, with its decision of March 17th, 1977 - II D 16/77 -, has rejected 16 petitions for a stop to building concerning the Kernkraftwerk Grohnde, two days before the site was invaded again. The main grounds upon which the rejection is based are given in full.

10265 Position of nuclear law within the legal order. Fischerhof, H. *Energiewirtsch. Tagesfragen;* **27**: No. 4, 251-253(Apr 1977). (In German).

New 'recipes' for integrating nuclear law into legal order of the FRG on the basis of the nuclear controversy are outlined critically: Actions brought by local joint boards or Buergerinitiatives; removal of the order for immediate execution; imposition of the condition to make use of a licence only when a court action has been won in the first instance; nuclear energy moratorium; referendum; decisions concerning sites to be made by the parliaments; special pre-licensing site approval procedures; new central advisory committee.

10266 Another building stop for Kernkraftwerk Brokdorf. Haeusler, D. *Energiewirtsch. Tagesfragen;* **27**: No. 4, 307-310(Apr 1977). (In German).

The Administrative Court Schleswig, with its decision of February 9th, 1977 - 10 D 176/76 -, has ordered another stop to building activities on the basis of the first partial licence concerning the erection of the Kernkraftwerk Brokdorf. The first partial licence only gave the go-ahead for preparatory site and ground work. The building firms also attending the court procedures have logded an appeal. The main grounds upon which the decision is based are given in full.

10267 Building stop ordered for Kernkraftwerk Muelheim-Kaerlich. *Energiewirtsch. Tagesfragen;* **27**: No. 3, 230-234(Mar 1977). (In German).

The Administrative Court at Koblenz, with its decision of February 4th, 1977 - 7 L 54/76 - has found for the petition of a high-school teacher concerning 'the restitution of the action's suspensive effect' for formal reasons. The petitioner protested against the 7th go-ahead for building on the basis of 'profound alterations' which would have required a special license according to section 7 of the Atomic Energy Act. The main reasons upon which the judgment is based are presented in full. (Comment: The stop to building has been cancelled in the meantime by the Higher Administrative Court at Koblenz).

10268 Building stop for Kalkar fast breeder rejected. *Energiewirtsch. Tagesfragen;* **27**: No. 3, 234-236(Mar 1977). (In German).

The Administrative Court at Duesseldorf, with its decision of January 20th, 1977 - 3 L 1337/76 - has rejected the application of a high-shool teacher in Moers for 'restitution of the claim's suspensive effect'. The costs of the procedure were awarded against the applicant. The decision also confirmed the exclusion of belated objections. The main reasons upon which the judgment is based are presented in full.

10269 Legal nuclear licensing procedure. Wagner, H. *VGB Kraftwerkstech.;* **57**: No. 2, 77(Feb 1977). (In German).

As an introduction, the presently practised legal nuclear licensing procedure will be demonstrated. The relation Federal Government/Lands (Countries), the consulting of various experts (GRS-IRS + LRA, TUEV, DWD, university institutions, engineering offices and others) the participation of the public e.g. presentation of documents, inquiries, protests (of individuals or groups, such as citizen initiatives) discussion dates, advices, a vidance of the advices, rights of immediate execution, were only discussed in a short form. Finally, possibilities for improvement of the licensing procedure, to begin with the valuation of documents to be submitted, presented and to be checked by (experts of) the authorities, up to the improvement of the administrative procedures have been discussed. A further developed procedure should justify not only the requirement to which the public is entitled by a sufficient transparence, but also the requirements to which the operators/manufacturers are entitled, so that finally the legally anchored right of the citizen to a safe and sufficient power supply by the electricity supply companies will be guaranteed. The continued energy program of the Federal Government, as well as the expedience of the discussion of legal nuclear questions in the various departments of a Land Government were discussed.

10270 French regulations for nuclear power plant reactor vessels. Vykutil, J. *Jad. Energ.;* **22**: No. 9, 349-350(Sep 1976). (In Czech).

The content of and criteria applied in French regulations for the primary coolant circuits of light water reactors are summed up. The demands are given on material, its testing and on the computation of the pressure vessel and pipe conduit with regard to reliability and safety. The regulations do not constitute a draft standard, nor do they determine the application of specific computation methods or of other standards. They make it possible to use experiments on models of actual material (determination of yield strength) and on the respective scale, as well as limit analyses which restrict the solutions from below and especially allow for the use of non-linear calculations using the finite element method. These calculations must be provided with a qualified report on the programme used.

ECONOMICS

REFER ALSO TO CITATION(S) 10405, 10578

10271 (COO—2865-10) **Net energy effects and resource depletion: an all-nuclear economy.** Penner, P.S.; Bullard, C.W.; Amado, D.L. (Illinois Univ., Urbana (USA). Center for Advanced Computation). Sep 1977. Contract EY-76-S-02-2865. 36p. Dep. NTIS, PC A03/MF A01.

This report evaluates the net energy balance for conventional nuclear power systems under the assumption that all inputs were produced using nuclear energy. The results are compared to other analyses which simply evaluated the marginal net energy balance assuming nuclear plants were produced and operated by today's energy production system and were, therefore, subsidized to some extent. It is shown that the nonlinear feedback effects due to the single-fuel-economy assumption are quite substantial. It is also shown that dynamic effects have a relatively small impact on the net energy balance.

10272 Promise and problems of nuclear energy. Roux, A.J.A. *S. Afr. Mech. Eng.;* **27**: No. 6, 183-189(Jun 1977).

This paper briefly reviews the present status and future prospects for nuclear technology with particular attention to possibilities in the fields of isotope separation and application, utilization of waste heat, food preservation, fuel reprocessing and the inevitability of the widespread use of commercial breeder reactors and eventual fusion power. Environmental concerns over nuclear reactors are also briefly discussed. Waste burial in impermeable strata is a suitable strategy for South Africa. The paper concludes that notwithstanding environmental concern, world dependence on nuclear power will increase.

10273 Markovian cross-impact model. Eymard, J. (Paris Airport Authority, 75657 Paris (France)). *Fys. Tidsskr.;* **9**: No. 3, 216-228(Jun 1977).

A cross-impact method is described which is based on Markov-chain theory. This allows scenarios to be derived which explicitly include the time dimension. An example of the use of the method is included which deals with the installation of nuclear reactors for energy production.

10274 Implementation of the nuclear power plant programme in Israel. Eilam, U. *Nucl. Eng. Int.;* **22**: No. 257, 59-62(May 1977).

The background to progress in the Israeli nuclear programme is described. Statistics are produced that show the importance of industry, electricity production and industrial consumption of energy, in the Israeli economy. A technical evaluation showed the feasibility of incorporating a large nuclear power station into a small isolated grid. Licensing, and present fuel activities are briefly discussed.

10275 Nuclear energy generation. Wahl, D.J. *Brennst.-Waerme-Kraft;* **29**: No. 4, 132-136(Apr 1977). (In German).

A survey is presented of the development of nuclear energy generation in the FRG in 1976. A total of 90 literature references with regard to this subject are cited.

10276 TOTEM-3 a computer code for the analysis of power station installation policies. Conti, F.; Graziani, G. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). *Energ. Nucl. (Milan);* **24**: No. 3, 154-164(1977).

The simulation program TOTEM-3 is described. Starting from the total electric energy demand in a given geographic area, the number and the power of plants of various type necessary to satisfy this demand can be calculated with this program, as well as the relevant demand of fuels, both conventional and nuclear, and possibly the costs of the produced energy. The effects of some bottlenecks in the nuclear fuel cycle (e.g. in the reprocessing phase) can also be considered. A calculation example referring to a possible Italian power policy is finally presented.

10277 Monte Carlo simulation used for nuclear power plant economic evaluations. Hoge, J.B. (Babcock and Wilcox Co., New York (USA)). *Energ. Nucl. (Milan);* **23**: No. 4, 207-211(1976).

In this article the computer code EVANC (Evaluation of Nuclear Costs) is described, which enables cost evaluations of nuclear power plants to be made through the use of probability analysis (Monte Carlo method). With EVANC the cumbersome sensitivity analysis normally used to measure the effect of changes in input variables is avoided.

CONSTRUCTION AND OPERATION

10278 Availability a particularly important notion for the economic evaluation of nuclear power plants. Hubert, E.H. (Union des Exploitants Electriques en Belgique, Brussels). *Elektro-Anz.;* No. 162, 11-16(1976). (In French).

Some important concepts of availability, utilization and different mathetmatical models of nuclear power plants are reviewed. The part of the availability in the evaluation of manufacturing cost and the different factors affecting the availability are considered, as well as some operational results.

FUEL CYCLE

10279 Nuclear power and its fuel cycle. Voelcker, H. (Steinkohlen-Elektrizitaet A.G. (STEAG), Essen (Germany, F.R.)). *Kerntechnik;* **19**: No. 4, 153-158(Apr 1977). (In German).

The contribution is a survey on the present technical and commercial situation in the field of the nuclear fuel cycle. Based on the nuclear energy programs in the countries of the Western world the problems of demand and supply are discussed for the different steps of the nuclear fuel cycle. In the Federal Republic of Germany, the work to be done in the next future will center on reprocessing of irradiated fuel elements and on the disposal of radioactive waste.

10280 Prospects of European cooperation on plutonium recycling for thermal reactors. Sani, L. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). *Com. Naz. Energ. Nucl., Not.;* **22**: No. 12, 29-34(Dec 1976). (In Italian).

From Nuclear symposium of Turin; Turin, Italy (27 Sep 1976).

The prospects of European cooperation in the field of the recycling of plutonium for thermal reactors can only be based on the one hand on the experience built up to this day in this specific sector, checking its limits of validity in purely objective terms, and on the other on an analysis of the areas of interest both within the framework of the Community R and D program for a concerted policy of utilization of plutonium and in view of an industrial rationalization of solutions on which several countries can agree.

10281 Nuclear fuel cycle issued in United States and Japan. Tamiya, S.; Meguro, T. (Enrich and Reprocessing Group, Tokyo (Japan)). *Genshiryoku Kogyo;* **22**: No. 9, 9-21(Sep 1976). (In Japanese).

Over ten years have elapsed after the initiation of commercial nuclear power generation, and about 9% in the United States and 7% in Japan of the total power generation are now produced by nuclear energy. For 20 years or so to come, power plants with light water reactors will be the main-stream. The aspects of the nuclear fuel cycle in the United States and Japan are described as follows: the scale of development of nuclear power generation, investments in the nuclear fuel cycle, supply of natural uranium, conversion to UF_6, uranium enrichment, fuel fabrication, temporary storage of spent fuel, transport of spent fuel, fuel reprocessing, and management of radioactive wastes.

10282 AEC committee debates nuclear fuel cycle. JAIF presents plan of action through 1990. *At. Jpn.;* **20**: No. 6, 17-23(Jun 1976).

Revision of the target scale of nuclear power development is reported, on which the conception of what the nuclear fuel cycle should be by 1990 was developed. The need for the following ideas and plans was stressed by Japan Atomic Industrial Forum (JAIF) from the point of view of priority and urgency regarding uranium resources, uranium enrichment, reprocessing, and treatment and disposal of radioactive wastes. The way should be cleared to ensure that the measures for securing uranium resources for the immediate future can be successful by establishing the method under the pay-when-successful formula and tax concession. The plans for building a Japanese enrichment plant should be accelerated. It is also necessary to consider the contracts for French and Soviet enrichment services, as means of assuring the diversity of supply sources for Japan. The second and later reprocessing plants should be considered from the points of view of establishing safety and effectively using natural resources (plutonium recycle). Specifically, plutonium recycling is very important to the effective use of natural fuel. Basic policies should be established as soon as possible for the management of both low-level and high-level radioactive wastes. For the high-level waste, the state authorities should accept final responsibility, and should promote international cooperation in the research and development of treatment and disposal techniques. The nuclear reactor regulations and other related laws should be revised to smooth the specific work of the nuclear fuel cycle.

10283 Nuclear fuel requirements in Egypt up to the year 2000. Hammad, F.H.; Ghoneim, M.M.; Abou-Zahra, A.A. (Atomic Energy Establishment, Inshas (Egypt)). *Arab J. Nucl. Sci. Appl.;* **9**: No. 1, 31-40(Jan 1976).

The nuclear fuel demands (as U_3O_8) in Egypt for the nuclear power and nuclear desalination programmes up to the year 2000 were calculated. The recent nuclear power forecasts of the International Atomic Energy Agency (IAEA) and the General Egyptian Electricity Coroporation (GEEC) were used as bases for calculation. The requirements were calculated for light and heavy water reactor (LWR and HWR) strategies. The cumulative uranium requirements for power and desalination programmes were found to be in the range of 19000-25000 tons in case of HWR strategy and 30000-400000 tons in case of LWR strategy. In the year 2000 alone the demands are expected to be 2000-2500 tons in case of HWR strategy and 3200-4000 tons in case of LWR strategy. Intensive uranium exploration coupled with a suitable reactor policy is essential to ensure the availability of these demands and for developing a local nuclear fuel technology.

PROCESS HEAT REACTORS

REFER ALSO TO CITATION(S) 10651

10284 (CONF-760646—, pp 269-274) **Gas core reactors for coal gasification.** Weinstein, H. (Illinois Inst. of Tech., Chicago). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

The concept of using a gas core reactor to produce hydrogen directly from coal and water is presented. It is shown that the chemical equilibrium of the process is strongly in favor of the production of H_2 and CO in the reactor cavity, indicating a 98 percent conversion of water and coal at only 1500°K. At lower temperatures in the moderator-reflector cooling channels the equilibrium strongly favors the conversion of CO and additional H_2O to CO_2 and H_2. Furthermore, it is shown the H_2 obtained per pound of carbon has 23 percent greater heating value than the carbon so that some nuclear energy is also fixed. Finally, a gas core reactor plant floating in the ocean is conceptualized which produces H_2, fresh water and sea salts from coal.

10285 (CONF-7605161—, pp 58-62) **Design considerations of hydrogen-power reactor systems.** Viswanathan, M.N. (Hunter District Water Board, Newcastle West, Australia). 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

The primary requirements of an ideal fuel would be (a) inexhaustible supply (b) low cost of production (c) high efficiency of conversion to electrical or mechanical energy (d) minimum pollution problems (e) ease of transportation, for use in automobiles. None of the existing fuels satisfies all the above requirements. The continued use of the present energy sources such as oil, natural gas and coal are creating far more problems in the form in which they are used today than ever before. Oil and natural gas are fast being depleted. Their cost of production has doubled and even trebled in some countries. The present conversion efficiencies of the above mentioned fuels are of order of 20 to 30% and they are highly polluting in nature. There are two feasible solutions to the above mentioned problem. Firstly, an alternative fuel may be found that satisfies most of the above requirements. Secondly, transformation of the existing primary energy sources into more acceptable forms, so that they could be made to satisfy the above requirements. There are already several projects in the pipeline in the above mentioned direction. Most promising among them are production of hydrogen from water/coal,

degasification of coal, desulfurization of fuel oil and production of synthetic natural gas (SNG). The recent development of high temperature gas cooled nuclear reactors (HTR's) has given new boost to the production of synthetic fuels. The present paper looks at one such scheme using HTR for the production of hydrogen and the thermodynamic aspects of design of such a scheme are discussed.

10286 Process for direct-reduction of iron-ore employing nuclear reactor-powered catalytic reformer. Barnhart, T.F. (to United States Steel Corp.). US Patent 4,047,935. 13 Sep 1977. Filed date 11 Dec 1974. 8p.

A method of reforming a fluid to make it suitable for use as a reducing gas in a direct reduction process is provided. The method is also taught in conjunction with a specific process for which it is particularly suited. The method uses a high-temperature gas-cooled nuclear reactor as a heat source for a catalytic reformer which is coupled with a cryogenic gas separation step to remove a substantial amount of the unreacted hydrocarbon. 14 claims, 3 figures.

10287 Review of the potential for the use of nuclear reactors for hydrogen production. Worley, N.G. (Babcock and Wilcox Ltd., London (UK)). *Energy Dig. (London)* ; **6**: No. 3, 40-44(Jun 1977).

The possibilities of using reactors to carry out high temperature chemical processes are considered briefly. The relevant characteristics of the high temperature gas cooled reactor and fast breeder reactors are summarized. The use of 'off-peak' electricity to produce hydrogen by the electrolysis of water is considered. Various problems, political, social, organizational and technical are discussed.

10288 Heat transport and storage. Despois, J. (Compagnie Generale de Matieres Nucleaires (COGEMA), 92-Chatillon (France)). *Rev. Gen. Nucl.;* No. 2, 84-88(Mar-Apr 1977). (In French).

From One-day meeting on the production and utilization of low and mean temperature heat of nuclear origin; Paris, France (22 Sep 1976).

Recalling the close connections existing between heat transport and storage, some general considerations on the problem of heat distribution and transport are presented 'in order to set out the problem' of storage in concrete form. This problem is considered in its overall plane, then studied under the angle of the different technical choices it involves. The two alternatives currently in consideration are described i.e.: storage in a mined cavity and underground storage as captive sheet.

10289 Hydrogen production from coal using a nuclear heat source. Quade, R.N. (General Atomic Co., San Diego, Calif. (USA)). *Int. J. Hydrogen Energy;* **2**: No. 2, 91-99(1977).

A strong candidate for hydrogen production in the intermediate time frame of 1990 to 1995 is a coal-based process using a high-temperature gas-cooled reactor (HTGR) as a heat source. Expected process efficiencies in the range of 60 to 70% are considerably higher than all other hydrogen production processes except steam reforming of a natural gas - a feedstock which may not be available in large quantities in this time frame. The process involves the preparation of a coal liquid, hydrogasification of that liquid, and steam reforming of the resulting gaseous or light liquid product. Bench-scale experimental work on the hydrogasification of coal liquids is being carried out. A study showing process efficiency and cost of hydrogen vs nuclear reactor core outlet temperature has been completed and shows diminishing returns at process temperatures above about 1500°F.

10290 Iron and steel industry in the nuclear age. Roume, J. *Usine Nouv., Suppl.;* No. 20, 28-29(13 May 1976). (In French).

The setting up of high-temperature reactors (HTR) with working temperature in the range 700 to 1000°C which can be used in the iron and steel industry is discussed. Above 850°C it is possible to extract H from natural gas and use it in the direct reduction of iron ore, a process recommended by the European Club of the Nuclear Iron and Steel Industry (Ensec) in London. The high temperature involved can also be used to gasify C and provide an alternative reducing gas. The HTR in Japan will also use the heat to reduce ion ore but at the temperature envisaged (approximately 1000°C) it will be necessary to create superalloys to contain the He coolant.

10291 Biological and artificial membranes and desalination of water. Passino, R. (ed.). Vatican City; Pontificia Academia Scientiarvm (1976). 932p. (CONF-7504131—).

From Study week on biological and artificial membranes and desalination of water; Rome, Italy (14 Apr 1975).

Papers are presented on biological and artificial membrane thermodynamics, ionic permeability and transport. Two papers discuss water needs and the importance of desalination. (HDR)

10292 Nuclear energy and water desalination. Leprince-Ringuet, L. (Ecole Polytechnique, Paris). pp 33-44 of In Biological and artificial membranes and desalination of water. Passino, R. (ed.). Vatican City; Pontifica Academia Scientiarvm (1976).

From Study week on biological and artificial membranes and desalination of water; Rome, Italy (14 Apr 1975).

Brief descriptions of procedures for desalination of sea or brackish waters are presented. The potential for dual-purpose nuclear plants for electricity production and desalination is discussed. (HDR)

NUCLEAR REACTOR TECHNOLOGY

THEORY AND CALCULATION

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10293 Progress in multidimensional neutron transport computation. Lewis, E.E. (Northwestern Univ., Evanston, IL). *Nucl. Sci. Eng.;* **64**: No. 2, 279-293(Oct 1977).

The methods available for solution of the time-independent neutron transport problems arising in the analysis of nuclear systems are examined. The merits of deterministic and Monte Carlo methods are briefly compared. The capabilities of deterministic computational methods derived from the first-order form of the transport equation, from the second-order even-parity form of this equation, and from integral transport formulations are discussed in some detail. Emphasis is placed on the approaches for dealing with the related problems of computer memory requirements, computational cost, and achievable accuracy. Attention is directed to some areas where problems exist currently and where the need for further work appears to be particularly warranted.

10294 (CONF-760646—, pp 64-72) **Energy distributions and radiation transport in uranium plasmas.** Miley, G.; Bathke, C.; Maceda, E.; Choi, C. (Univ. of Illinois, Urbana). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

Electron energy distribution functions have been calculated in a ^{235}U-plasma at 1 atmosphere for various plasma temperatures (5000 to 8000°K) and neutron fluxes (2×10^{12} to 2×10^{16} neutrons/(cm^2-sec)). Two sources of energetic electrons are included; namely fission-fragment and electron-impact ionization, resulting in a high-energy tail superimposed on the thermalized electron distribution. Consequential derivations from equilibrium collision rates are of interest relative to direct pumping of lasers and radiation emission. Results suggest that non-equilibrium excitation can best be achieved with an additive gas such as helium or in lower temperature plasmas requiring UF_6. An approximate analytic model, based on continuous electron slowing, has been used for survey calculations. Where more accuracy is required, a Monte Carlo technique is used which combines an analytic representation of Coulombic collisions with a random-walk treatment of inelastic collisions.

10295 (CONF-760646—, pp 136-145) **Properties of radio-frequency heated argon confined uranium plasmas.** Roman, W.C. (United Technologies Research Center, East Hartford, CT). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

An experimental investigation was performed to aid in determining the characteristics of uranium plasma core reactors. Pure uranium hexafluoride (UF_6) was injected into an argon-confined, steady-state, rf-heated plasma, within a fused-silica peripheral wall test chamber. Exploratory tests conducted using an 80 kW rf facility and different test chamber flow configurations permitted selection of the configuration demonstrating the best confinement characteristics and minimum uranium compound wall coating. The test chamber selected was 10-cm-long and 5.7-cm-inside diameter; operating pressures were up to 12 atm. A UF_6 handling and feeder system to provide a controlled and steady flow of heated UF_6 at temperatures up to 500°K and mass flow rates up to 0.21 g/s was employed.

10296 (CONF-760646—, pp 146-155) **Emission characteristics of uranium hexafluoride at high temperatures.** Krascella, N.L. (United Technologies Research Center, East Hartford, CT). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

An experimental study was conducted to ascertain the spectral characteristics of uranium hexafluoride (UF_6) and possible UF_6 thermal decomposition products as a function of temperature and pressure. Relative emission measurements were made for UF_6/Argon mixtures heated in a plasma torch over a range of tempera-

tures from 800 to about 3600°K over a wavelength range from 80 to 600 nm. Total pressures were varied from 1 to approximately 1.7 atm. Similarly absorption measurements were carried out in the visible region from 420 to 580 nm over a temperature range from about 1000 to 1800°K. Total pressure for these measurements was 1.0 atm.

10297 (CONF-760646—, pp 156-159) **Uranium plasma emission at gas-core reaction conditions.** Williams, M.D. (National Aeronautics and Space Administration, Hampton, VA); Jalufka, N.W.; Hohl, F.; Lee, J.H. Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

The results of uranium plasma emission produced by two methods are reported. For the first method a ruby laser was focused on the surface of a pure ^{238}U sample to create a plasma plume with a peak plasma density of about 10^{20} cm^{-3} and a temperature of about 38,600°K. The absolute intensity of the emitted radiation, covering the range from 300 to 7000 A was measured. For the second method, the uranium plasma was produced in a 20 kilovolt, 25 kilojoule plasma-focus device. The 2.5 MeV neutrons from the D-D reaction in the plasma focus are moderated by polyethylene and induce fissions in the ^{235}U. Spectra of both uranium plasmas were obtained over the range from 30 to 9000 A. Because of the low fission yield the energy input due to fissions is very small compared to the total energy in the plasma.

10298 (CONF-760646—, pp 170-177) **Heat transfer evaluation in a plasma core reactor.** Smith, D.E.; Smith, T.M.; Stoenescu, M.L. (Princeton Univ., NJ). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

Numerical evaluations of heat transfer in a fissioning uranium plasma core reactor cavity, operating with seeded hydrogen propellant, have been performed. A two-dimensional analysis is based on an assumed flow pattern and cavity wall heat exchange rate. Various iterative schemes were required by the nature of the radiative field and by the solid seed vaporization. Approximate formulations of the radiative heat flux are generally used, due to the complexity of the solution of a rigorously formulated problem. The present work analyzes the sensitivity of the results with respect to approximations of the radiative field, geometry, seed vaporization coefficients and flow pattern. The results present temperature, heat flux, density and optical depth distributions in the reactor cavity, acceptable simplifying assumptions, and iterative schemes.

10299 (CONF-760646—, pp 188-196) **Parametric analyses of planned flowing uranium hexafluoride critical experiments.** Rodgers, R.J.; Latham, T.S. (United Technologies Research Center, East Hartford, CT). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

Analytical investigations were conducted to determine preliminary design and operating characteristics of flowing uranium hexafluoride (UF_6) gaseous nuclear reactor experiments in which a hybrid core configuration comprised of UF_6 gas and a region of solid fuel will be employed. The results indicate that confined flow tests of a gaseous UF_6-uranium fuel element hybrid core configuration appear feasible. A preliminary design is described for an argon buffer gas confined, UF_6 flow loop system for future use in flowing critical experiments. Flowing gaseous UF_6 would be confined within the cavity core canister by tangential injection of argon buffer gas to produce a radial inflow vortex flow pattern.

10300 (CONF-760646—, pp 197-204) **Circulation system for flowing uranium hexafluoride cavity reactor experiments.** Jaminet, J.F.; Kendall, J.S. (United Technologies Research Center, East Hartford, CT). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

Accomplishment of the UF_6 critical cavity experiments, currently in progress, and planned confined flowing UF_6 initial experiments requires development of reliable techniques for handling heated UF_6 throughout extended ranges of temperature, pressure, and flow rate. The development of three laboratory-scale flow systems for handling gaseous UF_6 at temperatures up to 500 K, pressures up to approximately 40 atm, and continuous flow rates up to approximately 50 g/s is presented. A UF_6 handling system fabricated for static critical tests currently being conducted at Los Alamos Scientific Laboratory (LASL) is described. The system was designed to supply UF_6 to a double-walled aluminum core canister assembly at temperatures between 300 K and 400 K and pressures up to 4 atm. A second UF_6 handling system designed to provide a circulating flow of up to 50 g/s of gaseous UF_6 in a closed-loop through a double-walled aluminum core canister with controlled temperature and pressure is described.

10301 (CONF-760646—, pp 205-210) **Measurements of uranium mass confined in high density plasmas.** Stoeffler, R.C. (United Technologies Research Center, East Hartford, CT). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

An x-ray absorption method for measuring the amount of uranium confined in high-density, rf-heated uranium plasmas is described. Preliminary tests were conducted to calibrate the measurement system using argon, uranium hexafluoride (UF_6), and mixtures of argon and UF_6 at room temperature. A comparison of measured absorption of 8 keV x-rays with absorption calculated using Beer's Law indicated the method could be used to measure uranium densities from 3×10^{16} atoms/cm^3 to 3×10^{18} atoms/cm^3. Tests were conducted to measure the density of uranium in an rf-heated argon plasma with UF^6 injection and with the power to maintain the discharge supplied by the United Technologies Research Center (UTRC) 1.2-MW rf induction heater facility. The uranium density was measured as the UF_6 flow rate through the test chamber was varied. A maximum uranium density of 3.85×10^{17} atoms/cm^3 was measured.

10302 (CONF-760646—, pp 224-238) **Plasma core reactor applications.** Latham, T.S.; Rodgers, R.J. (United Technologies Research Center, East Hartford, CT). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

Analytical and experimental investigations are being conducted to demonstrate the feasibility of fissioning uranium plasma core reactors and to characterize space and terrestrial applications for such reactors. Uranium hexafluoride (UF_6) fuel is injected into core cavities and confined away from the surface by argon buffer gas injected tangentially from the peripheral walls. Power, in the form of thermal radiation emitted from the high-temperature nuclear fuel, is transmitted through fused-silica transparent walls to working fluids which flow in axial channels embedded in segments of the cavity walls. Radiant heat transfer calculations were performed for a six-cavity reactor configuration; each cavity is approximately 1 m in diameter by 4.35 m in length. Axial working fluid channels are located along a fraction of each cavity peripheral wall.

10303 (CONF-760646—, pp 263-268) **Application of gaseous core reactors for transmutation of nuclear waste.** Schnitzler, B.G.; Paternoster, R.R.; Schneider, R.T. (Univ. of Florida, Gainesville). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

The transmutation potential of a thermal spectrum uranium hexafluoride fueled cavity reactor was examined. Initial studies focused on a heavy water moderated cavity reactor fueled with 5 percent enriched U^{235}-F_6 and operating with an average thermal flux of 6×10^{14} neutrons/cm^2-sec. The isotopes considered for transmutation were I-129, Am-241, Am-242m, Am-243, Cm-243, Cm-244, Cm-245, and Cm-246.

10304 (KFK—2441) **Experimental investigation of the turbulent flow through a wall subchannel of a rod bundle.** Rehme, K. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Schneller Brueter). Apr 1977. 114p. (In German). Dep. NTIS (US Sales Only), PC A06/MF A01.

An experimental investigation was performed to establish reliable information on the transport properties of turbulent flow through subchannels of rod bundles. Detailed data were measured of the distributions of the time-mean velocity, the turbulence intensities in all directions and, thus, the kinetic energy of turbulence, of the shear stresses in the directions normal and parallel to the walls, and of the wall shear stresses for a wall subchannel of a rod bundle of four rods in parallel. The pitch-to-diameter ratio of the rods equal to the wall-to-diameter ratio was 1.07, the Reynolds number of this investigation was $Re = 8.7 \times 10^4$. On the basis of the data measured the eddy viscosities in the directions normal and parallel to the walls were calculated. Thus, detailed data of the eddy viscosities in direction parallel to the walls in rod bundels were obtained for the first time. The experimental results were compared with predictions by the VELASCO-code. There are considerable differences between calculated and measured data of the time-mean velocity and the wall shear stresses. Attempts to adjust the VELASCO-code against the

measurements were not successful. The reasons of the discrepancies are discussed.

10305 (LA-NUREG—6917-MS) **Fission-product source terms for reactor applications.** England, T.R.; Stamatelatos, M.G.; Schenter, R.E.; Schmittroth, F. (Los Alamos Scientific Lab., N.Mex. (USA)). Aug 1977. Contract W-7405-ENG-36. 27p. Dep. NTIS, PC A03/MF A01.

Calculated and measured fission-product source terms are presented. The emphasis is on decay heating following fission for use in the development of a new ANS decay heat standard. Comparisons with experiment are given for β and γ spectra, and energy-integrated values. Calculated results for gaseous content, absorption effects on decay heating, absorption buildup in reactors, and photoneutron spectra are summarized. Uncertainty analyses based on nuclide data (ENDF/B-IV) and on combined decay-heat experiments are provided.

10306 Approximate solutions of the two-dimensional integral transport equation by collision probability methods. Sanchez, R. (CEN de Saclay, Gif-sur-Yvette, France). *Nucl. Sci. Eng.;* **64**: No. 2, 384-404(Oct 1977).

A set of approximate solutions for the isotropic two-dimensional neutron transport problem has been developed using the interface current formalism. The method has been applied to regular lattices of rectangular cells containing a fuel pin, cladding, and water, or homogenized structural material. The cells are divided into zones that are homogeneous. A zone-wise flux expansion is used to formulate a direct collision probability problem within a cell. The coupling of the cells is effected by making extra assumptions on the currents entering and leaving the interfaces. Two codes have been written: The first uses a cylindrical cell model and one or three terms for the flux expansion, and the second uses a two-dimensional flux representation and does a truly two-dimensional calculation inside each cell. In both codes, one or three terms can be used to make a space-independent expansion of the angular fluxes entering and leaving each side of the cell. The accuracies and computing times achieved with the different approximations are illustrated by numerical studies on two benchmark problems.

10307 Nodal coupling by response matrix principles. Ancona, A. (Rensselaer Polytechnic Inst., Troy, NY); Becker, M.; Beg, M.D.; Harris, D.R.; Menezes, A.D.; VerPlanck, D.M.; Pilat, E. *Nucl. Sci. Eng.;* **64**: No. 2, 405-417(Oct 1977).

The response matrix approach has been used in viewing a reactor node in isolation and in characterizing the node by reflection and trans-emission factors. These are then used to generate invariant imbedding parameters, which in turn are used in a nodal reactor simulator code to compute core power distributions in two and three dimensions. Various nodal techniques are analyzed and converted into a single invariant imbedding formalism.

10308 Smoothing and extrapolation techniques for reactor kinetics. Lawrence, R.D. (Univ. of Illinois, Urbana); Dorning, J.J. *Nucl. Sci. Eng.;* **64**: No. 2, 492-507(Oct 1977).

A smoothing and extrapolation method is applied to the point kinetics equations and the one-dimensional space-dependent reactor kinetics equations. The simple smoothing procedure is shown to be very efficient in reducing the oscillatory errors that occur when the standard Pade(1,1) and Crank-Nicholson approximations are applied to stiff reactor kinetics equations. Fourth-order accuracy is achieved by applying a single Richardson extrapolation (on a global basis) to the smoothed results obtained from values calculated using two time-step grids. The numerical results for point kinetics demonstrate that the method is particularly efficient for very stiff problems such as subcritical and delayed supercritical transients in fast reactors. Application of the method to two one-dimensional kinetics benchmark problems solved using a standard space-dependent computer code that utilizes the Crank-Nicholson approximation leads to significant reduction in the overall computational effort required to achieve a given accuracy.

10309 High-order schemes for neutron kinetics calculations, based on a local polynomial approximation. Langenbuch, S.; Maurer, W.; Werner, W. (Gesellschaft fuer Reaktorsicherheit mbH, Garching, Ger.). *Nucl. Sci. Eng.;* **64**: No. 2, 508-516(Oct 1977).

A systematic study of the accuracy and efficiency of a class of asymmetric weighted residual methods, as applied to neutron diffusion equations, is presented. Polynomials up to the sixth order are considered, with and without mixed spatial derivative terms. It turns out that the sixth-order polynomial with mixed derivative terms is most efficient; yet, for normal reactor conditions, sufficiently accurate results can already be obtained with a third-order polynomial without mixed-derivative terms.

10310 Conservation of the adjoint neutron spectrum by use of bilinear-weighted cross sections and its effect on fast reactor calculations. Wade, D.C.; Bucher, R.G. (Argonne National Lab., IL). *Nucl. Sci. Eng.;* **64**: No. 2, 517-538(Oct 1977).

Flux weighting for the generation of broad-group cross sections is designed to preserve eigenvalue, flux spectrum, and reaction rates; however, it will not preserve adjoint spectrum and reactivity worths. Bilinear (flux-adjoint) weighting preserves all of the above quantities except reaction rates. Bilinear weighting also makes the eigenvalue of the broad-group calculation less sensitive to distortions of the spectrum away from the fundamental mode over which the cross sections were collapsed than is the case when flux weighting is used. A series of 29- and 11-group numerical tests has been made to assess the size of errors (relative to a fine-group standard) in eigenvalue, reaction rate ratios, isotopic worth components, and spectral shapes resulting from the use of the two energy collapse procedures. The errors in adjoint spectrum and calculated worth of scattering materials are found to be large when flux weighting is used.

10311 Current trends in methods for neutron diffusion calculations. Adams, C.H. (Argonne National Lab., IL). *Nucl. Sci. Eng.;* **64**: No. 2, 552-562(Oct 1977).

Current work and trends in the application of neutron diffusion theory to reactor design and analysis are reviewed. Specific topics covered include finite difference methods, synthesis methods, nodal calculations, finite element methods, and perturbation theory.

10312 Finite element depletion diffusion calculation method with space-dependent cross sections. Kavenoky, A.; Lautard, J.J. (CEN de Saclay, Gif-sur-Yvette, France). *Nucl. Sci. Eng.;* **64**: No. 2, 563-575(Oct 1977).

A new solution method for the diffusion depletion equation is presented. Space-dependent macroscopic cross sections are represented in the framework of a finite element basis, and the finite element method is extended to deal with these space-dependent cross sections. This method has been implemented in the NEPTUNE system of reactor calculation to be applied to two- and three-dimensional depletion calculation of large reactors. Numerical calculations are presented, and comparisons are performed with standard methods.

10313 Energy-dependent finite element method for two-dimensional diffusion problems. Komoriya, H. (EBASCO Services, Inc., New York); Walters, W.F. *Nucl. Sci. Eng.;* **64**: No. 2, 576-581(Oct 1977).

The effectiveness of the energy-dependent finite element method (EDFEM) as applied to two-dimensional multigroup diffusion problems is investigated. The EDFEM couples the finite element method (FEM) formalism with the energy-dependent element size scheme. The EDFEM allows the elements to straddle material interfaces if certain conditions are satisfied; this method is especially suitable for heterogeneous reactor calculations. Comparisons of the results obtained by the EDFEM, the FEM, and the finite difference method for a ZION-1 pressurized water reactor model are presented. A significant reduction of the total number of unknowns involved in the problem is accomplished by using the EDFEM, which yields a reduction of the computing time by 30 percent.

10314 Two nodal methods for solving time-dependent group diffusion equations. Shober, R.A.; Sims, R.N.; Henry, A.F. (Massachusetts Inst. of Tech., Cambridge). *Nucl. Sci. Eng.;* **64**: No. 2, 582-592(Oct 1977).

Two methods are developed for solving the transient group diffusion equations for reactors composed of large homogeneous nodal regions. In the first scheme, nodal coupling constants are in effect computed by an analytical method; in the second, a polynomial expansion of the flux is used. Both methods yield accurate static and dynamic results in very short computing times.

10315 Optimized iteration strategies and data management considerations for fast reactor finite difference diffusion theory codes. Ferguson, D.R.; Derstine, K.L. (Argonne National Lab., IL). *Nucl. Sci. Eng.;* **64**: No. 2, 593-604(Oct 1977).

Optimized iteration methods for the solution of large-scale fast reactor finite difference diffusion theory calculations are presented, along with their theoretical basis. The computational and data management considerations that went into their formulation are discussed. The methods utilized include a variant of the Chebyshev acceleration technique applied to the outer fission source iterations and an optimized block successive overrelaxation method for the within-group iterations. The performance of a computer code employing these methods is compared with that of several existing production diffusion theory codes for a range of typical problems.

10316 Theory, capabilities, and use of the three-dimensional reactor operation and control simulator (ROCS). Ober, T.G. (Combustion Engineering, Inc., Windsor, CT); Stork, J.C.; Rickard, I.C.; Gasper, J.K. *Nucl. Sci. Eng.;* **64**: No. 2, 605-623(Oct 1977).

A three-dimensional coarse-mesh reactor simulator is described that provides a good balance between computational speed and numerical accuracy. The system and theoretical methods have been verified by comparison with such conventional fine-mesh diffusion theory methods as the PDQ reactor code. The accuracy of the

computational method has been determined to be an improvement over alternative methods through extensive comparisons between measurement and calculation for up to three cycles of reactor operation.

10317 Convergence results and asymptotic error estimates for Galerkin-type spectral synthesis. Nelson, P.; Meyer, H.D. (Texas Tech Univ., Lubbock). *Nucl. Sci. Eng.;* **64**: No. 2, 638-643(Oct 1977).

The problem considered in the paper is the continuous-energy, continuous-space time-independent neutron-diffusion equation, with given source and zero flux at the boundary. The basic result is that Galerkin-type spectral synthesis approximations converge optimally to the exact solution as the number of trial spectra increases, provided the diffusion coefficient and total macroscopic cross section are spatially homogeneous, and other (more) reasonable conditions of a technical nature are satisfied. The proof makes use of the general results of Pol'skii, which give sufficient conditions for the convergence of any projection method using the same trial and test spaces. As an application of the basic result, it is shown that the classic multigroup method converges optimally provided the maximum group width over any fixed bounded energy interval approaches zero. Several directions are indicated for possible related future work.

10318 Method for measuring power signal background and source strength in a fission reactor. Baers, B.; Kall, L.; Visuri, P. (Valtion Teknillinen Tutkimuskeskus, Otaniemi (Finland). Reaktorimateriaaliryhmae). *Nucl. Instrum. Methods;* **143**: No. 1, 199-201(15 May 1977).

Theory and experimental verification of a novel method for measuring power signal bias and source strength in a fission reactor are reported. A minicomputer was applied in the measurements. The method is an extension of the inverse kinetics method presented by Mogilner et al.

10319 Conjugate heat transfer effects on local symmetric can thermal and thermoelastic stress perturbations. Thompson, J.J.; Chen, P.Y.P. (New South Wales Univ., Kensington (Australia). School of Nuclear Engineering). *Nucl. Eng. Des.;* **24**: No. 3, 305-312(May 1977).

The importance of including a model for conjugate heat transfer in the formulation of the problem of can temperature and thermoelastic stress resulting from local perturbations in power density and internal surface heat flux has been demonstrated by numerical studies. Further developments in the mathematical modelling include the use of the Galerkin method for the heat conduction problem and of the fast Fourier transform (FFT) technique for both thermal and thermoelastic aspects of the problem.

10320 Difference approach to the solution of heterogeneous reactor equations. Kochurov, B.P.; Malofeev, V.M. *At. Energ. (USSR);* **42**: No. 2, 87-90(Feb 1977). (In Russian).

For English translation see the journal Sov. At. Energy.

A method is proposed to transform heterogeneous reactor equations into a finite difference form enabling to calculate reactors consisting of several thousand blocks. A general interpretation of heterogeneous equations in the small group approximation is employed. A numerical solution of a finite difference equation in a monopole small group approximation for a square lattice, using 9- and 5-point schemes is compared with the results of direct computer calculations. In the case of the 9-point scheme the neutron group fluxes are pointed out to differ by no more than a few tenths of per cent, and the effective breeding ratios-by no more than a few hyndredths of per cent. The theory described is constructed for a monopole approximation, coheres whereas it may be used to solve the heterogeneous equations in a dipole approximation as well.

10321 Instabilities in parallel channel of forced-convection boiling upflow system. 2. Experimental results. Aritomi, M.; Aoki, S.; Inoue, A. (Tokyo Inst. of Tech. (Japan). Research Lab. of Nuclear Reactor). *J. Nucl. Sci. Technol. (Tokyo);* **14**: No. 2, 88-96(Feb 1977).

The instabilities observed in a parallel-channel system carrying boiling fluid in forced upward flow have been studied theoretically and experimentally, using water as test fluid. The limits of the stable flow in such a parallel-channel system (the stable boundary) are sought, and the nature of inlet flow oscillation in the unstable region has been examined experimentally under various conditions of inlet velocity, heat flux, liquid temperature, cross section of channel and entrance throttling. The results obtained are compared with calculations based on the mathematical model reported in a companion paper, and good agreement is seen between analysis and experiment in respect of the stable boundary. The experimental results are further examined through phase analysis using the same model.

10322 Improved intermediate resonance method for heterogeneous media. Chiovato, O. (Applicazioni e Ricerche Scientifiche, Milan (Italy)); Corno, S. (Politecnico di Torino (Italy)); Pasquantonio, F.Di. (Ente Nazionale per l'Energia Elettrica, Milan (Italy)). *Ann. Nucl. Energy;* 4: No. 2, . 91-106(1977).

A new formulation is described of the Intermediate Resonance method which incorporates the previous developments suitably modified and improved, together with some new contributions. The 'intermediate' character is directly introduced in the integral operator K, allowing a more rigorous deduction of the equations for evaluating the intermediate parameters related to the nuclides involved in the system. There is no limit to the number of internal (admixed in the fuel) and external moderators. The capability to take into account the interference scattering has been extended to heterogeneous systems. The Doppler broadening is described by means of new accurate rational approximations to the broadened line shape psi. Finally the use of energy mean values suitably defined refines the values of the resonance integrals and resonance absorption cross sections. The Intermediate Resonance method so extended and improved, has been coded in a group of FORTRAN routines, which have been inserted as a calculation option in the fast section of the GGC code for the evaluation of multigroup cross sections. A series of calculations has been carried out, using these routines, and comparisons have been made with Monte Carlo and Nordheim's methods. The results obtained show that the Intermediate Resonance method developed in the present work offers considerable advantages over Nordheim's method: better accuracy in evaluating resonance absorption cross sections, and much smaller computing times.

10323 Investigation of the possibility of using static calculations (adiabatic-approximation) in the theory of neutron-noise. Kosaly, G.; Mesko, L.; Pazsit, I. (Central Research Institute of Physics, Budapest (Hungary)). *Ann. Nucl. Energy;* **4**: No. 2, . 79-89(1977).

The adiabatic approximation is the most simple one of the space-dependent models of reactor kinetics. Using this approximation kinetic problems can be solved via well-developed static methods of calculation. The adiabatic-model of linear noise-theory is formulated. Its validity for solving noise-problems is discussed in connection with the simple example of a localized absorber of variable strength.

10324 Measurement of neutron noise in the presence of a vibrating control plate. Oka, Y.; An, S. (Tokyo Univ. (Japan). Faculty of Engineering); Tomii, K.; Tamura, K. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Ann. Nucl. Energy;* **4**: No. 2, . 127-133(1977).

Results of at-power reactor noise experiments conducted at JRR-4 are presented. The magnitude and the frequency spectrum of the fluctuation of neutron flux are analysed under various operating conditions. Three characteristic results are obtained: (1) the magnitudes and the frequency components in the relative fluctuation of the neutron flux do not alter at various power levels; (2) decrease of flow rate makes the neutron flux fluctuation weak; (3) the change of the shim plate position also varies the frequency components in the fluctuation. Based on these results the cause of the neutronic noise of this reactor is inferred to be the flow induced reactivity perturbation especially due to the lateral vibration of a shim plate. The vibration itself is measured simultaneously with the fluctuation of neutron flux under reactor operating condition. The correlation between these signals are examined. Very high coherence and extremely similar frequency spectra of both fluctuations are obtained and it is definitely shown that the cause of the noise in JRR-4 is the lateral vibration of the shim plate under forced circulation of coolant. It is noticeable that the frequency spectra of the shim plate vibration have a broad spectrum at low frequency region in contrast to the common understanding that the frequency spectra of vibration of core components have only discrete frequency components. The method of inferring source of noise from the behaviour of the neutronic fluctuation under several power levels, coolant flow rates and control rod positions is useful where it is difficult to measure the source of noise itself.

10325 Hidden state-variables and a non-Markoffian formulation of reactor noise. Nishigori, T.; Kishida, K.; Sekiya, T. (Osaka Univ., Suita (Japan). Faculty of Engineering). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 12, 708-714(Dec 1976).

A non-Markoffian Langevin equation $df(t)/dt = -\int_{sub(t_0)}^{sup(t)} B(t-t')f(t')dt' + Z(t-t_0)g(t_0) + F(t)$ for the fluctuations of known state-variables, f(t), is proposed. The non-Markoffian effect and the new stochastic term $Z(t-t_0)g(t_0)$ are due to "hidden" state-variables g(t). The random force F(t) meets the requirement of the causality condition, but the random force given by $R(t) = Z(t-t_0)g(t_0) + F(t)$ does not. A new relation between the fluctuation R(t) and the dissipation B(t) is found. The effect of external noise sources is formulated to demonstrate that the present formalism is useful for finding out hidden state-variables.

10326 Theory of third order moments-related reactor noise experiments with delayed neutrons. Watson, F.V. (Rio de Janeiro Univ. (Brazil). Corrdenacao dos Programas de Pos-graduacao de Engenharia). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 12, 683-690(Dec 1976).

A general theory of third order moments-related reactor noise pulse experiments is presented. Detailed computation of a two-intervals moment of counts for a zero power one velocity point

reactor with delayed neutrons is performed. The neutronic process is analyzed up to third order covariances via an extension of the usual mobility and diffusion matrices' approach. For this purpose, a stochastic diffusion matrix and a third order stochastic diffusion tensor are introduced. Detection effects are taken into account through a non-homogeneous Poisson distribution. No a priori approximation for the probability generating function of counts is assumed.

10327 Lattice parameter measurements on cluster-type fuel for advanced thermal reactor. Hachiya, Y.; Fukumura, N.; Nishi, A.; Iijima, K.; Sakata, H. (Power Reactor and Nuclear Fuel Development Corp., Oarai, Ibaraki (Japan). Oarai Engineering Center). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 11, 618-632(Nov 1976).

The behavior of neutrons in a highly heterogeneous unit cell consisting of D_2O moderator, H_2O coolant and a 28-pin fuel cluster contained in a pressure tube has been studied through lattice parameter measurements covering three different ^{235}U enrichments, four coolant void fractions and two lattice pitches. A single-region core configuration was adopted, with which measurements were made to determine - in relation to coolant void fraction - the critical D_2O level, as well as various lattice parameters. A strong dependence on coolant void was observed for the critical level and the lattice parameters, in the case of the smaller 22.5cm pitch lattice, due to the positive effect on core reactivity exerted by the slowing-down faculty of H_2O in the epithermal energy region. With the larger 25.0cm pitch, however, no meaningful dependence on void fraction was shown by any of the measured values, and this was ascribed to a compensating negative effect due to enhanced thermal neutron self-shielding in the fuel region produced by the H_2O coolant. The results of cell calculations obtained by means of the METHUSE-LAH-II code showed generally good agreement with experimentally determined data, for both critical D_2O levels and lattice parameters, in the case of coolant-filled lattices (0, 30 and 70% void fractions). For lattices devoid of coolant (100% void fraction), however, discrepancies in lattice parameters - particularly in rho^{28} - produced corresponding deviations in core reactivity amounting to 1% in excess of those incurred with other void fractions.

10328 Distribution of two-phase flow thermal and hydraulic parameters over the cross-section of channels with a rod bundle. Mironov, Yu.V.; Shpanskii, S.V. *At. Energ. (USSR);* **39**: No. 6, 403-408(Dec 1975). (In Russian).

The paper describes PUCHOK-2, a program for thermohydraulic calculation of a channel with a bundle of smooth fuel elements. The program takes into consideration the non-uniformity of flow parameter distributions over the channel cross-section. The channel cross-section was divided into elementary cells, within which changes in flow parameters (mass velocity, heat- and steam content) were disregarded. The bundle was considered to be a system of parallel interconnected channels. Accounting for equal pressure drops in all the cells, the above model led to a system of non-linear algebraic equations. The system of equations was solved by the method of successive approximations. Theoretical results were compared with experimental data.

10329 Kinetics of a system of coupled pulsed reactors. Kolesov, V.F.; Petrov, Yu.V.; Shtarev, S.K. *At. Energ. (USSR);* **39**: No. 6, 392-396(Dec 1975). (In Russian).

The kinetics of a system of two connected pulse reactors, one of which, at least, had a coefficient of temperature extinction differing from zero, were studied. The entire system was assumed to operate in a mode of powerful self-quanching pulses, i.e. in a mode in which unsteady-state processes were determined solely by internal associations and initial reactivity values. Equations and corresponding analytical and numerical solutions are cited to describe unsteady-state processes in the system. The dependence of pulse characteristics upon the system inlet dimensions was investigated on the basis of the above solutions.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 10450

10330 (CENPD—255) **Class 1E qualification. Qualification of Class 1E instrumentation.** (Combustion Engineering, Inc., Windsor, Conn. (USA)). Jul 1977. 55p. Engineering, Inc., Windsor, CT.

This report describes the methods used to meet the requirements of IEEE Std. 323-1974 for qualification of Class 1E Combustion Engineering supplied instrumentation for nuclear power plants. The general scope of various qualification programs is discussed. The types of components included and data on these systems, modules and components are discussed. Type tests, analysis, and other methods of qualification are presented. Documentation for qualification is described with sample data sheets provided.

10331 (GKSS—77/E/8, pp 12-32) **Comparison of seven models for calculating the steam content in the region of subcooled boiling and their application to heating channels with heat-flux density distribution.** Kaffanke, E. (Technische Univ. Berlin (Germany, F.R.). Inst. fuer Kerntechnik). 1977. (In German).

From Specialist's meeting on the physics of feedback processes in nuclear reactors; Geesthacht, F.R. Germany (22 Jan 1976).

In Physics of feed back process in nuclear reactors.

After a phenomenolocigical description of subcooled boiling, the principles of calculating the steam content are explained. Subsequently, results of different models are discussed by the example of some reactors.

10332 (RDT-M—5-23T) **Steel plates for nuclear and other special applications (ASME SA-647 with additional requirements).** (Department of Energy, Washington, D.C. (USA). Div. of Reactor Development and Demonstration). Sep 1977. Contract W-7405-ENG-26. 13p. .

This standard covers carbon steel, and medium and high alloy steel plates, sheets, and strips for nuclear and associated applications.

10333 Fuel transfer system for a nuclear reactor. Katz, L.R.; Marshall, J.R.; Desmarchais, W.E. (to Westinghouse Electric Corp.). US Patent 4,053,067. 11 Oct 1977. Filed date 25 Jun 1973. 10p.

Disclosed is a fuel transfer system for moving nuclear reactor fuel assemblies from a new fuel storage pit to a containment area containing the nuclear reactor, and for transferring spent fuel assemblies under water from the reactor to a spent fuel storage area. The system includes an underwater track which extends through a wall dividing the fuel building from the reactor containment and a car on the track serves as the vehicle for moving fuel assemblies between these two areas. The car is driven by a motor and linkage extending from an operating deck to a chain belt drive on the car. A housing pivotally mounted at its center on the car is hydraulically actuated to vertically receive a fuel assembly which then is rotated to a horizontal position to permit movement through the wall between the containment and fuel building areas. Return to the vertical position provides for fuel assembly removal and the reverse process is repeated when transferring an assembly in the opposite direction. Limit switches used in controlling operation of the system are designed to be replaced from the operating deck when necessary by tools designed for this purpose. 5 claims, 8 figures.

10334 Motor-driven screwing and transporting tool for reactor pressure vessel head retaining fastenings. Scholz, M. (to Kraftwerk Union AG). US Patent 4,047,456. 13 Sep 1977. Priority date 17 Dec 1974, German, Federal Republic of (F.R. Germany). 14p.

The invention concerns a motor-driven screwing and transporting tool for tightening or loosening the threaded studs and associated tightening nuts of the head bolting of pressure vessels. After the tightening nuts are loosened or before they are tightened, the weight of the studs is taken over by rotating bearings that can be lifted, so that the studs with their tightening nuts can be screwed in or out, the screw threads of the studs being thus weight-relieved. The invention is intended primarily for nuclear reactor pressure vessels. 21 claims, 6 figures.

10335 Pressure vessel especially for a nuclear reactor. Schilling, F. (to Siempelkamp Giesserei KG). US Patent 4,047,632. 13 Sep 1977. Priority date 28 Nov 1974, German, Federal Republic of (F.R. Germany). 6p.

Disclosed is a pressure vessel, containment, or burst shield for a nuclear reactor which has a substantially circular cover (closing the top or bottom of a cylindrical casing or shell) comprised of a plurality of layers, each formed from a multiplicity of segments meeting a central part. The adjoining segments of each layer meet at joints which are staggered with respect to the joints of the adjacent layers above or below and hence no continuous crevices are provided through the cover. Tension members extend through aligned passages of the several layers and provide support against shear and thrust forces. 6 claims, 9 figures.

10336 Evaluation of in-core measurements with self-powered detectors. Spoden, E. (VEB Kombinat Kraftwerksanlagenbau, Berlin (German Democratic Republic)). *Kernenergie;* **20**: No. 9, 287-288(Sep 1977). (In German).

A calculational method is presented for transformation of n-β currents into relative thermal neutron fluxes taking into account an epithermal correction. The difference between epithermal corrections with cross section ratios is demonstrated based on calculations with NR approximation and multiplied by the ratio of mean epithermal and thermal first collision probabilities as well as on calculations using the model of infinite dilution. The effects of this difference on axial power density distribution, relative power of the fuel assemblies, and the inhomogeneity coefficients are discussed in the light of a characteristic measurement with rhodium emitter in a WWER-type reactor. The effect of errors in the nuclear data on the mean error of relative thermal neutron flux is evaluated.

10337 Method and a device for thermal monitoring of a nuclear reactor core. Barbier, G. (to Commissariat a l'Energie Atomique). US Patent 4,045,282. 30 Aug 1977. Priority date 4 Mar 1975, France. 6p.

Thermal monitoring of a reactor core is carried out by utilizing coolant temperatures detected at the outlets of a plurality of fuel assemblies. The mean value of the "hot" and "cold" core outlet temperatures and the difference between the latter are established at each instant. An analog signal corresponding to the temperature difference between the coolant temperature at the outlet of said assembly and the mean core outlet temperature is delivered in respect of each fuel assembly. The signal is processed in order to initiate the appropriate safety actions. 6 claims, 1 figure.

10338 Nuclear reactor fuel containment safety structure. Rosewell, M.P. US Patent 4,045,284. 30 Aug 1977. Filed date 10 Mar 1975. 6p.

A nuclear reactor fuel containment safety structure is disclosed and is shown to include an atomic reactor fuel shield with a fuel containment chamber and exhaust passage means, and a deactivating containment base attached beneath the fuel reactor shield and having exhaust passages, manifold, and fluxing and control material and vessels. 1 claim, 8 figures.

10339 Qualtity assurance in nuclear technology. Roesler, U. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **22**: No. 6, 347-351(Jun 1977). (In German).

From Reactor congress 1977; Mannheim, Germany, F.R. (29 Mar - 1 Apr 1977).

1 fig.; 2 tabs.

The demand for safety in nuclear power plants is rooted in the Atomic Energy Act of the Federal Republic of Germany, under which 'preplanned safety' is a licensing condition. Moreover, the safety of nuclear power plants is outlined in more precise terms in the guidelines of the German Advisory Committee for Reactor Safeguards (Reaktorsicherheitskommission). The usual approach taken in this country, i.e., to establish quality assurance for each specific product, with supplementary quality assurance measures geared to systems requirements being implemented by industry, has proved to work satisfactorily. Product-based quality assurance mainly stems from the classical quality control concept, whereas systems-based quality assurance primarily is to ensure that both manufacturers and systems suppliers take all measures in advance which are needed for the satisfactory processing of an order and to achieve the quality level required. The special features and the advantages of the joint action of manufacturers, systems suppliers and experts, which are characteristic of the German approach, very clearly emerge from a comparison with practices in the United States. In the further refinement of the quality assurance concept as practised in Germany, qhich will have a particularly great impact on costs and schedules because of the manpower requirement involved, it should be carefully weighed where there are exaggerations and unnecessary complications which can no longer be justified by the demand for more safety.

10340 Streaming problems are the major worry for shielding experts. Martin, A. (Associated Nuclear Services, Epsom (UK)). *Nucl. Eng. Int.;* **22**: No. 258, 30-31(Jun 1977).

The fifth international conference on reactor shielding was held in Knoxville, Tennessee, from 18 to 23 April, 1977 and was sponsored primarily by Oak Ridge National Laboratory. The design problems associated with LMFBR and fusion facilities were covered in many papers. Other aspects covered in detail were the recently encountered streaming problems and the increasing difficulties posed by activated corrosion products in LWR plants.

10341 Acoustic transducer for nuclear reactor monitoring. Ahlgren, F.F.; Scott, P.F. (to Energy Research and Development Administration). US Patent 4,020,693. 3 May 1977. Filed date 12 Apr 1976. 6p.

PAT-APPL-675,843.

Disclosed is a transducer to monitor a parameter and produce an acoustic signal from which the monitored parameter can be recovered. The transducer comprises a modified Galton whistle which emits a narrow band acoustic signal having a frequency dependent upon the parameter being monitored, such as the temperature of the cooling media of a nuclear reactor. Multiple locations within a reactor are monitored simultaneously by a remote acoustic receiver by providing a plurality of transducers each designed so that the acoustic signal it emits has a frequency distinct from the frequencies of signals emitted by the other transducers, whereby each signal can be unambiguously related to a particular transducer. 8 claims, 1 figure.

10342 Ultrasonic thermometer isolation standoffs. Arave, A.E. (to Energy Research and Development Administration). US Patent 4,020,692. 3 May 1977. Filed date 26 Sep 1975. 6p.

PAT-APPL-617,125.

A method is provided for minimizing sticking of the transmission line to the protective sheath and preventing noise echoes from interfering with signal echoes in an improved high temperature ultrasonic thermometer which includes an ultrasonic transmission line surrounded by a protective sheath. Small isolation standoffs are mounted on the transmission line to minimize points of contact between the transmission line and the protective sheath, the isolation standoffs serving as discontinuities mounted on the transmission line at locations where a signal echo is desired or where an echo can be tolerated. Consequently any noise echo generated by the sticking of the standoff to the protective sheath only adds to the amplitude of the echo generated at the standoff and does not interfere with the other signal echoes. 6 claims, 3 figures.

10343 Two-dimensional steady temperature distribution in a composite geometry reactor vessel subjected to nuclear radiation: an analytical solution. Coppari, L.A.; Thomas, J.R. Jr. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). *Nucl. Eng. Des.;* **24**: No. 3, 361-373(May 1977).

A two-dimensional solution is derived for the steady-state temperature profile in a reactor vessel considering internal heat generation, bimetallic structure and composite geometry. Numerical results are given for a typical case which can be used as the initial conditions for transient studies of vessels subjected to thermal shock.

10344 Inspectors should be an operators's friend. Reisch, F.; Forsberg, S. *Nucl. Eng. Int.;* **22**: No. 257, 63-64(May 1977).

Nuclear inspectors and power station operators have many objectives in common. Examples are given of cases where practices and decisions that improve safety also benefit availability, such as the early detection of failures and leakages, preventing the spread of damage.

10345 Salts of the iodine oxyacids in the impregnation of adsorbent charcoal for trapping radioactive methyliodide. Deitz, V.R.; Blachly, C.H. (to Energy Research and Development Administration). US Patent 4,016,242. 5 Apr 1977. Filed date 26 Feb 1976. 4p.

PAT-APPL-661,572.

Radioactive iodine and radioactive methyliodide can be more than 99.7 percent removed from the air stream of a nuclear reactor by passing the air stream through a 2-inch thick filter which is made up of impregnated charcoal prepared by contacting the charcoal with a solution containing KOH, iodine or an iodide, and an oxyacid, followed by contacting with a solution containing a tertiary amine. 3 claims.

10346 Investigation method for nonstationary processes in components of heat exchange equipment. Sharovarov, G.A.; Bernatskaya, A.M.; Tashchilova, E.M.; Zenich, T.S. (AN Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 1, 61-65(1977). (In Russian).

A method of investigating nonstationary processes in heat-exchange equipment is presented. It is based on the division of the investigation process into two stages. At the first stage nonstationary processes in the coolant and components that have a substantial effect on the coolant parameters are investigated in a one-dimensional approximation. At the second stage nonstationary fields in the components of heat-exchange equipment are investigated. The results obtained at the first stage are the boundary conditions for the calculations at the second stage. To investigate the dynamics of heat-exchange equipment mathematical models have been developed for two stages of the investigation. The analysis has shown that all components that are in contact with the coolant substantially affect the coolant parameters. The computer solution of a set of differential and algebraic equations describing the dynamics of the coolant of a heat-exchanger and a nuclear reactor is the result of the first stage of the investigations. The results obtained are the boundary conditions for the determination of nonstationary temperature fields in the components of the heat-exchanger and the reactor. To determine the nonstationary temperature field, a spatial object is divided into a number of unit volumes. A thermal equilibrium equation is written for every unit volume. A set of differential equations of thermal equilibrium is solved on a digital computer, as a result nonstationary temperature fields for a superheater-evaporator and an economizer are obtained.

10347 Stability and dynamic response of pressurized journal bearings with nuclear water pump applications. Barrett, L.E.; Allaire, P.E.; Gunter, E.J. (Virginia Univ., Charlottesville (USA)). *Ann. Nucl. Energy;* **4**: No. 2, . 115-126(1977).

The solution of the Reynold's equation for short journal bearings is obtained by considering ambient pressure levels above the fluid cavitation pressure. Equilibrium load carrying capacity and linearized bearing stiffness and damping coefficients are calculated for various values of ambient pressure. The effect of ambient pressure on journal stability is considered and an instability threshold speed map presented. A nonlinear transient analysis gives orbits which compare well with experimental results. Applications include the effects of pressurization on the stability of feed water pump

bearings in nuclear reactors and plain seals in turbomachinery. A rotor undergoing stable motions whirls synchronously with operating speed producing bending stresses which are constant over time. Unstable motion created by pressurization cause stress reversals in the shaft. Such motion may increase to large amplitudes. The final size of the limit cycle rotor orbits depends on the nonlinearities in the rotor system.

10348 Three-dimensional finite element programmes for stress analysis. Alujevic, A. (Maribor Univ. (Yugoslavia)). *Atomkernenergie;* **29**: No. 3, 189-191(1977).

A three-dimensional, hexahedral, isoparametric finite-element code theory and running experience is reported in the paper.

10349 Vibration of a pipe induced by unsteady flowing fluid. Koishikawa, A. (Kawasaki Heavy Industries Ltd., Kobe (Japan)). *FAPIG (Tokyo);* No. 82, 43-47(Aug 1976). (In Japanese).

The vibration of a simply supported pipe induced by a suddenly introduced unsteady flow was analyzed theoretically. First, vibrational characteristics of a pipe when an unsteady flow is introduced into the pipe were analyzed. A kinetic equation for the movement of the pipe is introduced with the boundary conditions. Equations representing the dynamic response of the pipe are then derived. These equations are solved by a computer code CART. The second part of this paper exposes the detail of the code and the results of a sample calculation. Outline and the limitations of the code, methods of numerical calculation (including assumptions and basic equations), and the flow chart are described. The dynamic response of the piping system is computed with a proven code NASTRAN. Input and output informations of the code are also explained together with the results of a sample calculation.

10350 New Ganz-MAVAG type pumps developed for the Paks Nuclear Power Plant. Jozsa, I. (Foevarosi Vizmuevek, Budapest (Hungary)). *Engei Gakkai Zasshi;* **29**: No. 9, 385-394(1976). (In Hungarian).

From Meeting on hydrology; Szentrendre, Hungary (Nov 1975).

In the first period of its operation the Paks Nuclear Power Plant (880 MW) needs a cooling water supply of 53 m^3/s. The data of hydraulic designs and the constructional arrangement of the pumps developed for the cooling water supply of the condenser and for the safety water supply are presented.

10351 Continuous radiochemical analysis of fission products in a nuclear reactor water coolant. Moskvin, L.N.; Zakharov, L.K.; Leont'ev, G.G.; Mel'nikov, V.A.; Orlenkov, I.S.; Slutskii, G.K. *At. Energ. (USSR);* **39**: No. 6, 412-415(Dec 1975). (In Russian).

Method for continuous radiochemical analysis of I, Cs, Ba, Sr and Ce isotopes in a reactor water heat-transfer agent was developed. A continuous two-dimensional chromatographic process of complex mixtures separation of substances proved to be feasible on several parallel sorbent layers, which moved at constant velocities and separated by stationary intermediate collectors. Tests on model solutions containing I, Ce, Cs and Ba isotopes and on heat-carrier samples showed quantitative separation of elements. The results were indicative of a basic possibility of using multisorbent chromatographs for continuous control of multicomponent mixtures, particularly for control of radioactive fission product compositions in water heat-transfer agents in nuclear power plants. A diagram is shown for a two-dimensional chromatographic separation of a multicomponent mixture. Also shown is a flow chart of an installation for continuous control of iodine and cesium isotope activities.

10352 Means for preventing radioactive fluid leaking. Akatsu, J. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-127,994/A/. 30 Apr 1975. 4p. (In Japanese).

A means to permit prevention of leakage of radioactive fluid from line and valve leak sections while also recovering the liquid by producing a vacuum state in a leak-off line by means of a water ejector is described. A portion of the water from a condenser is forced by a condensed water pump through a water ejector tank to a recovery tank while controlling an orifice and valve, whereby a vacuum state is produced in the leak-off line to withdraw the leakage fluid.

10353 Internal component element for a reactor. Itoi, H. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-126497/A/. 28 Apr 1975. 4p. (In Japanese).

A system is disclosed whose purpose is to suppress vibrations of a neutron detector assembly so as to protect a neutron detector assembly and fuel assembly from wear and damage while also enhancing the precision of measurement at the time of measuring neutron flux by interposing a vibration prevention means between the neutron detector assembly and fuel assembly. A vibration prevention means which is made of a metal softer than that of the channel of the fuel assembly is interposed between the neutron detector assembly and fuel assembly. With this arrangement, vibrations produced by the flow of reactor water or earthquakes are suppressed by the vibration prevention means and not transmitted to the neutron detector.

10354 Method of control of combustible gas within a nuclear container. Horiuchi, T.; Yamanari, S. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-110198/A/. 24 Mar 1975. 4p. (In Japanese).

A system is disclosed whose object is to dispense with recirculation gas in a reaction step for recombination of oxygen and hydrogen produced from decomposition of leaking water occurring due to such cause as breakage of the recirculation system duct by previously pouring non-combustible gas into the gas supplied to the reaction step. The concentration of oxygen and the concentration of hydrogen within the nuclear container are detected after an accident, and non-combustible gas is then supplied into the nuclear container by opening a non-combustible gas bomb valve according to the results of the detection such that hydrogen concentration within the container is always held below 4%. In this way, the quantity of oxygen reacted in a recombiner is reduced to below 2% without recirculating the gas.

10355 Feed water control device. Miyagaki, H. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-104191/A/. 10 Mar 1975. 3p. (In Japanese).

A device is disclosed whose object is to attain proper automatic control of the level of water in a nuclear reactor over a wide range of from below 35% of the rated output from an automatic power plant to the full rated output by switching a feed water control device automatically to either one-element or three-element control, depending upon the main steam flow rate. The feed water control device is responsive to a reactor water level signal, a main steam flow rate signal and a feed water flow rate signal and constructed so that switching is possible between a single-element controller (input with an error signal between the water level signal and a set water level) and a three-element controller (input with the above-mentioned error signal plus an error signal between the feed water flow rate and the main steam flow rate) by means of an adder and an indicating controller. A switch is operated in relation to the magnitude of an output from a set-value setting device in which the signal indicative of the main steam flow rate or the signal indicative of the flow rate of feed water is compared with their individual set values so that one-element control is chosen when the main steam flow rate or the flow rate of feed water is smaller than their individual set values and three-element control is chosen when the main steam flow rate or the flow rate of feed water is larger than their individual set values. (Kamimura, M.).

FUEL ELEMENTS

10356 Fuel assembly with easily detachable components. van Santen, A. (to Aktiebolaget ASEA-ATOM). US Patent 4,045,287. 30 Aug 1977. Priority date 30 Dec 1974, Sweden. 2p.

A fuel assembly is disclosed which includes a bundle of vertical fuel rods. Some of the rods are tying rods provided with extended upper end plugs, and the rest of the rods are spring-furnished ones, the spring forces balancing the tying forces exerted by the tying rods between a top plate and a bottom plate. The top plate is grid-like and provided with attachment holes for the upper end plugs. The lower end plugs of the tying rods are screwed in threaded holes in the bottom plate. Each of the upper end plugs of the tying rods has a portion located above the top plate and provided with a nut. Rotation of the nut is limited by at least one downwardly directed projection on the nut, the end surface of which lies below the upper edge of the top plate. The maximally allowable length of this projection is less than the maximum shortening of the springs that can be carried out by exerting a downwardly directed force on the top plate. With such a projection length the projections can clear the side and the nut can be rotated and removed. 1 claim, 5 figures.

10357 Nuclear fuel element. Armijo, J.S. (to General Electric Co.). US Patent 4,045,288. 30 Aug 1977. Filed date 11 Nov 1974. 12p.

A nuclear fuel element for use in the core of a nuclear reactor is disclosed which has a composite cladding having a substrate, a metal barrier metallurgically bonded to the inside surface of the substrate and an inner layer metallurgically bonded to the inside surface of the metal barrier. In this composite cladding, the inner layer and the metal barrier shield the substrate from any impurities or fission products from the nuclear fuel material held within the composite cladding. The metal barrier forms about 1 to about 4 percent of the thickness of the cladding and is comprised of a metal selected from the group consisting of niobium, aluminum, copper, nickel, stainless steel, and iron. The inner layer and then the metal barrier serve as reaction sites for volatile impurities and fission products and protect the substrate from contact and reaction with such impurities and fission products. The substrate and the inner

layer of the composite cladding are selected from conventional cladding materials and preferably are a zirconium alloy. Also in a preferred embodiment the substrate and the inner layer are comprised of the same material, preferably a zirconium alloy. 19 claims, 2 figures.

10358 Nuclear reactor fuel element with vanadium getter on cladding. Johnson, C.E.; Carroll, K.G. (to Energy Research and Development Administration). US Patent 4,032,400. 28 Jun 1977. Filed date 17 Feb 1976. 4p.
PAT-APPL-658,805.

A nuclear reactor fuel element is described which has an outer cladding, a central core of fissionable or mixed fissionable and fertile fuel material and a layer of vanadium as an oxygen getter on the inner surface of the cladding. The vanadium reacts with oxygen released by the fissionable material during irradiation of the core to prevent the oxygen from reacting with and corroding the cladding. Also described is a method for coating the inner surface of small diameter tubes of cladding with a layer of vanadium. 5 claims, 1 figure.

10359 Iterative method for assessing the importance of hairline cracks in fuel rods upon the thermoelastic loop stress in surrounding cans. Barrett, P.R. (New South Wales Univ., Kensington (Australia). School of Nuclear Engineering). *Nucl. Eng. Des.;* **24**: No. 3, 345-360(May 1977).

The problem of the thermal resistance of radial cracks in fuel rods containing a spatial thermal source gradient is treated as a problem in potential theory containing mixed boundary conditions. The geometry of each crack is idealized and the small effects of radiative heat transfer across cracks and any thermal conduction through the gas filling the cracks are ignored by assuming perfectly thermally insulating boundary conditions on crack surfaces. Such ideal conditions allow the maximum effect of the cracks on the temperature distribution in the surrounding can to be assessed by solving for the temperature distribution by means of series expansions and choosing an iterative method as a means of satisfying the mixed nature of the boundary conditions. The mean value of the first azimuthal harmonic of the temperature distribution is examined in particular and to illustrate the effect of perturbations in its magnitude, the purely thermoelastically induced hoop stress in the can is examined for the same azimuthal harmonic.

10360 Fuel element design. Chapter 11. MacDonald, P.E. (Idaho National Engineering Lab., Idaho Falls (USA)); Wang, I.-C. (Cincinnati Univ., Ohio (USA)). pp 303-342 of In Elements of nuclear reactor design. Weisman, J. (ed.) (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). Amsterdam, The Netherlands; Elsevier (1977).

The in-reactor behavior of fuel-element materials is considered in this chapter. The application of the principles of mechanical analysis to fuel-element design is then examined in light of this behavior. Since uranium dioxide enriched with small amounts of either ^{235}U or plutonium oxide and encapsulated in metal tubes is the predominant fuel of present power reactors, this consideration is limited to elements of this general type.

10361 Gas release from uranium dioxide. Samsonov, B.V.; Sidorov, V.V.; Spiridonov, Yu.G.; Sulaberidze, V.Sh.; Tsykanov, V.A. *At. Energ. (USSR);* **40**: No. 5, 390-395(May 1976). (In Russian).

A method has been developed and used for a direct measurement of the amount of gaseous fission products being liberated during the irradiation on fuel elements. The kinetics of gas liberation has been studied with two series of fuel elements: with or without a zone of columnar crystals. In all the experiments the total error in determining the amount of gas is 8% or less. It is shown that in the process of irradiation one can distinguish a section of the initial splash of gas liberation, that of weak gas liberation and that of intense gas liberation. The change in the amount of gases under the jacket, which causes the initial splash, occurs as a result of the desorption of those technological gases from the surface of the uranium dioxide being heated have accumulated there during its processing and storage. The weak section of gas liberation results from the accumulation of about 0.3 nano-cm^3/t of UO_2 as a gaseous fission product in the zone of equiaxial grains of fuel elements. The section of intense gas liberation is due to a considerable discharge of gaseous fission products out of the zone of equiaxial grains of fuel elements, which increases with depletion. Data are given on the sorption of gaseous fission products on the fuel surface during reactor shutdowns.

10362 Gas release from a failed fuel pin after reactor shut-down. Pshenichnikov, B.V. *At. Energ. (USSR);* **39**: No. 6, 400-402(Dec 1975). (In Russian).

A mathematical model of gassing from a hypothetical core fuel element in the active zone of a stopped water-moderated reactor was analysed to investigate the process of liberation of gaseous fission products from an unpressurized fuel element. A one-dimensional problem was obtained as a result of the accepted hypotheses. A fault was assumed to have occured during reactor operation; at the same time, a vapour-gas mixture was considered to be present under the envelope at reactor working pressure by the moment of stoppage. An approximative estimation was made of the retardation time of pressure balancing at the open end of the fuel element, and also of the amount of total gas remaining in the gap under the fuel element envelope after pressure drop in the reactor. Estimation of retardation time permitted to conclude that pressure in the nonhermetic fuel element envelope follows pressure fluctuation in the reactor in the course of cooling, the retardation time of pressure balancing outside and inside the fuel element lasting but a few seconds.

10363 Fuel assembly. Tarutani, K. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-140089/A/. 28 May 1975. 3p. (In Japanese).

To form orifices for controlling flow of coolant within an assembly to render outlet temperature of the coolant uniform, a handling head is disposed at the upper part of a cladding tube for supporting a multitude of fuel rods to form coolant flow passages, and a flow controller (orifice), which varies in sectional area in proportion to the temperature of coolant, is provided interiorly thereof to constitute a fuel assembly. By the provision of such flow controller, the flow controlling may be accomplished, even in case of different heating value of assemblies, to optimize the temperature distribution of coolant.

10364 Fuel assemblies. Ito, K.; Ishii, T.; Honda, Y. (to Mitsubishi Atomic Power Industries, Inc., Tokyo (Japan)). Japanese Patent 1976-138295/A/. 27 May 1975. 4p. (In Japanese).

A fuel assembly is disclosed which is simple in construction and in which distribution of coolant flow is made corresponding to distribution of heating value of the fuel assembly to create a temperature differential within the fuel assembly. In a fuel element arranged within an outer cylinder, in addition to a first helical spacer there is disposed another helical spacer in a position at a distance of 60° to 120° at a phase angle relative to said first helical spacer in the outer periphery of a first fuel element arranged in the neighbourhood of the outer cylinder.

10365 Nuclear fuel elements. Une, K. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-138294/A/. 27 May 1975. 3p. (In Japanese).

A method is claimed too prevent stress corrosion or the like of a zircaloy cladding tube resulting from iodine. Iodine getter made of silver, magnesium, iron, copper or the like is interposed between a cladding tube for a nuclear fuel element, in which a zircaloy cladding tube is filled with sintered pellets of uranium oxide system, and the surface into which pellets may contact.

10366 Nuclear fuel assemblies. Yoshida, H.; Sekiguchi, M. (to Nuclear Fuel Industries Ltd., Tokyo (Japan)). Japanese Patent 1976-114589/A/. 31 Mar 1975. 5p. (In Japanese).

To provide a mechanism for externally partially flowing a part of coolant within a fuel assembly, a nuclear fuel assembly is disclosed which comprises the desired number of assemblies disposed within a reactor in spaced relation to receive coolant through orifices in a lower tie plate, said coolant being upwardly passed through fuel rods arranged in spaced apart between the lower tie plate and an upper tie plate, said assemblies including tubular channels received in both the tie plates, the improvement consisting in a bimetal flow regulating member disposed between the tubular channels and the lower tie plate so that said member is reversely bended in response to heat resulted from operation of the reactor to be held in contact with the channels even following deformation of the tubular channels.

10367 Method of reproducing fuel assemblies. Maki, H.; Hosokawa, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-105594/A/. 5 Feb 1975. 6p. (In Japanese).

A method is disclosed to reproduce a fuel assembly by charging new fuel rods having a composition close to that of a material influenced on fission reaction contained in the fuel rods. Spare fuel rods having a composition of material influenced on fission reaction according to a degree of combustion of fuel rods charged into a fuel assembly positioned in a core of a reactor are prepared, broken fuel rods are taken out of the fuel assembly and the spare fuel rods having a composition closest to that of the material influenced on the fission reaction contained in the taken-out broken fuel rods are charged into the fuel assembly to thereby reproduce a fuel assembly in a manner so as not to produce variation in output distribution of the fuel assembly.

CONTROL SYSTEMS

10368 (CONF-760241—) **Proceedings of the symposium on power plant dynamics and control.** (Department of Atomic Energy,

Bombay (India). Engineering Sciences Advisory Committee). 1976. 525p.

From Symposium on power plants dynamics and control; Trombay, India (23 Feb 1976).

Papers are included on the dynamics and control of nuclear and non-nuclear power plants.

10369 (NEDO—10466(Rev.1)) **Power Generation Control Complex, design criteria and safety evaluation.** Clay, H.R. (General Electric Co., San Jose, Calif. (USA). Nuclear Energy Control and Instrumentation Dept.). Sep 1977. vp. Electric Co., San Jose, CA.

The compliance of General Electric's Power Generation Control Complex (PGCC) with the applicable safety criteria is described. To accomplish this a brief description of the PGCC is presented followed by a detailed discussion of the specific safety-related requirements and the corresponding PGCC design compliance. In some cases, compliance is demonstrated by an analytical study and in others by documentation and tests. A section on plant interfaces has been included to facilitate reviews of individual plant safety analysis reports. An understanding of what can and cannot be done by a customer/AE to maintain the safety integrity of PGCC is of prime importance in the review process. There are three basic Nuclear Steam Supply System configurations utilizing the PGCC concept=BWR/4, BWR/5 and BWR/6. This report discusses the BWR/6 version of PGCC followed by a separate section on the BWR 4 and 5 differences. Since there are only a few differences in the applicable requirements between the three, this section is rather brief. The safety evaluations presented also apply to the BWR/4 and BWR/5 designs.

10370 (WCAP—8976) **Failure Mode and Effects Analysis (FMEA) of the solid state full length rod control system.** Shopsky, W.E. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). 1977. vp. Electric Corp., Pittsburgh, PA.

The Full Length Rod Control System (FLRCS) controls the power to the rod drive mechanisms for rod movement in response to signals received from the Reactor Control System or from signals generated through Reactor Operator action. Rod movement is used to control reactivity of the reactor during plant operation. The Full Length Rod Control System is designed to perform its reactivity control function in conjunction with the Reactor Control and Protection System, to maintain the reactor core within design safety limits. By the use of a Failure Mode and Effects Analysis, it is shown that the FLRCS will perform its reactivity control functions considering the loss of single active components. That is, sufficient fault limiting control circuits are provided which blocks control rod movement and/or indicates presence of a fault condition at the Control Board. Reactor operator action or automatic reactor trip will thus mitigate the consequences of potential failure of the FLRCS. The analysis also qualitatively demonstrates the reliability of the FLRCS to perform its intended function.

10371 **Flexible position probe assembly.** Schmitz, J.J. (to Westinghouse Electric Corp.). US Patent 4,052,686. 4 Oct 1977. Filed date 16 Oct 1975. 10p.

The combination of a plurality of tubular transducer sections and a flexible supporting member extending through the tubular transducer sections forms a flexible elongated probe of a design suitable for monitoring the level of an element, such as a nuclear magnetically permeable control rod or liquid. 3 claims, 23 figures.

10372 **Methods for identification of dynamic systems.** Frogner, B.; Friedlander, B.; Rao, H.S. (Systems Control, Inc., Palo Alto, CA). *Nucl. Sci. Eng.*; **64**: No. 2, 644-656(Oct 1977).

A discussion of methods for identification of dynamic systems is presented. Problems and methods for determining model structures and estimating unknown parameters are considered. The maximum likelihood (ML) formulation for parameter estimation is discussed in detail due to its generality and its success in numerous applications. An outline is given of the steps and the computational considerations involved in a system identification problem. The benefits of identifying the process and observation noise sources and then applying the ML approach as opposed to the classical least-squares technique are discussed. Present and potential applications in the nuclear industry are reviewed.

10373 **Method of and apparatus for checking the dimensions of the extensions of the control rods of a nuclear reactor.** Weilbacher, J.C. (to Societe France-Americaine de Constructions Atomiques-Framatome). US Patent 4,048,009. 13 Sep 1977. Priority date 14 Mar 1975, France. 6p.

Disclosed is a method of checking the dimensions of the extensions of control rods of a nuclear reactor when the extensions are located in a cooling pit or fuel storage pool under a safe depth of water, comprising placing each extension vertically on a reference support in the cooling pit, the support having a profile corresponding to that of the extensions, moving measuring pick-ups, calibrated by reference to the support, along the extension, measuring the distances between the pick-ups and the extension at a plurality of levels, and analyzing the measurements. An apparatus is also disclosed for performing the novel method of checking rod-extension dimensions in the nuclear reactor. 5 claims, 2 figures.

10374 **Control rod drive for nuclear reactors.** Eschenfelder, G.; Schultz, R. (to Kraftwerk Union Aktiengesellschaft). US Patent 4,048,010. 13 Sep 1977. Priority date 11 Feb 1975, German, Federal Republic of (F.R. Germany). 14p.

A nuclear reactor control rod drive for finely adjustable normal insertion and withdrawal of control rods from the reactor core, for scramming the control rods, as well as for locking the control rods in their respective rated position, the insertion being effected in a direction opposing the force of gravity, and the withdrawal being effected in direction of the force of gravity, includes a piston rod mounted so as to be displaceable in axial direction, the piston rod being couplable to respective control rods for driving the same, a threaded piston rotatably mounted on the axially displaceable piston rod, screw thread means supporting the threaded piston so that the piston is movable back and forth hydraulically, the screw thread means having controllable locking means for clearing the screw thread means stepwise in the back and forth direction so that the threaded piston is displaceable into and out of the reactor core stepwise to effect fine adjustment, the screw thread means, in condition of the control rod drive wherein the control rods are being scrammed, being clearable throughout by the locking means so that the piston rod entrains a respective control rod at a scram velocity that is increased in comparison to the velocity of the control rod during normal insertion thereof into the reactor core. 18 claims, 14 figures.

10375 **Automatic motion inhibit system for a nuclear power generating system.** Musick, C.R.; Torres, J.M. (to Combustion Engineering, Inc.). US Patent 4,046,625. 6 Sep 1977. Filed date 18 Aug 1975. 16p.

Disclosed is an automatic motion inhibit system for a nuclear power generating system for inhibiting automatic motion of the control elements to reduce reactor power in response to a turbine load reduction. The system generates a final reactor power level setpoint signal which is continuously compared with a reactor power signal. The final reactor power level setpoint is a setpoint within the capacity of the bypass valves to bypass steam which in no event is lower in value than the lower limit of automatic control of the reactor. If the final reactor power level setpoint is greater than the reactor power, an inhibit signal is generated to inhibit automatic control of the reactor. 6 claims, 5 figures.

10376 **Method of operating a nuclear reactor.** Aleite, W.; Bock, H.W. (to Siemens AG). US Patent 4,046,624. 6 Sep 1977. Priority date 17 Sep 1973, German, Federal Republic of (F.R. Germany). 6p.

A pressurized-water reactor with a core height of at least 3.5 m, is operated by using at least 50 measuring probes which are distributed throughout the core and which feed into a computer. The latter computes in advance a program of operation, by which individual control rods are adjusted, regardless of load changes, over the height of the core in such a manner that local power peaks are avoided. 6 claims, 5 figures.

10377 **Control rod and/or instrument tree assembly.** Noyes, R.C.; Dupen, C.F.G.; Barrus, D.M.; Siegel, E.A. (to Combustion Engineering, Inc.). US Patent 4,045,283. 30 Aug 1977. Filed date 30 Dec 1974. 14p.

Disclosed is an improved core servicing apparatus for a nuclear reactor having a vessel, a head for the vessel, one or more penetration openings in the head and a core within the vessel of the type having an array of fuel assemblies and including apertures in the array for neutron absorbers. The servicing apparatus includes a support column adapted to be supported by and depend from the head in registry with a penetration opening; a plurality of core servicing elements which may include neutron absorber actuating means and/or instrument packages are supported by the support column; and means are provided for laterally displacing at least some of the servicing elements relative to the support column between a laterally compact and a laterally expanded configuration. In one embodiment, instruments may be located at the lower end of long resilient cables and are longitudinally movable within and beyond guide channels supported by the support column. The guide channels are directed outward at their lower ends to direct a descending instrument and cable outwardly. 9 claims, 18 figures.

10378 **Anti-ejection system for control rod drives.** Matthews, J.C. US Patent 4,044,622. 30 Aug 1977. Filed date 18 Feb 1975. 8p.

A linearly movable latch mechanism is provided to move into engagement with a deformable collet whenever an undesired ejection of a leadscrew is initiated from a nuclear reactor mounted control rod drive. Such an undesired ejection would occur in the event of a rupture in a housing of the control rod drive. The collet is deformed by the linear movement of the latch mechanism to wedge itself against the leadscrew and prevent the ejection of the leadscrew from the housing. The latch mechanism is made to be controllably

engageable with the leadscrew and when thus engaged to allow the leadscrew to move in a control direction while moving with the leadscrew to engage and deform the collet when the leadscrew moves in an ejection direction. 13 claims, 2 figures.

10379 Tubular gage for a liquid-metal-cooled fast breeder reactor. Hutter, E.; Tuma, L.A. (to Energy Research and Development Administration). US Patent 4,028,811. 14 Jun 1977. Filed date 2 Mar 1976. 12p.
PAT-APPL-663,179.

Spring-loaded plungers are arranged about a housing for insertion into a polygonal tube, one plunger for each side of the tube. Each plunger has a locking cam and sliding wedge mechanism which can overcome the spring force associated with the plunger and lock it in any position. The wedges are operated by a rod movable axially in the housing. Several housings with their associated plungers can be stacked. The stack is lowered into the polygonal tube with all of the plungers locked in a fully inward position. When the stack is in the tube, each wedge is moved to release its locking cam, allowing each of the plungers to spring outward against an inner side of the tube. Each housing will thus gage the internal dimensions of the tube at its elevation. The plungers are locked in position, the entire stack is rotated to bring the plungers into the corners described by the intersections of the flat sides, and the stack is removed from the tube whereupon the dimensions across opposite locked plungers may be read by a micrometer.

10380 Developments in multivariable plant and core control. Beraha, D. (Laboratorium fuer Reaktor regelung und Anlagensicherung). *J. Inst. Nucl. Eng.;* **18**: No. 3, 81-86(May-Jun 1977).

It is stated that much effort has been made to apply multivariable control theory to control problems in nuclear power plants. Two problems are here discussed, the control of the power distribution in the reactor core, and the control of the whole plant. In both cases, some of the proposed control systems have reached a stage of development where application in power plants is being considered. So far, tests have been performed on reactor simulators or small experimental plants only. For realization in commercial power plants, safety related and economic aspects are being studied and will play an important role. The most important approaches to power distribution control are reviewed briefly. Then, a concept for plant control is presented and its various design stages described in more detail. Attention is given mainly to light water reactors, but the generality of the methods allows application to a wide range of other reactor types.

10381 Instrumentation and control systems on PFR. McAffer, N.T.C. *J. Inst. Nucl. Eng.;* **18**: No. 3, 66-73(May-Jun 1977).

An account is given of the instrumentation and control systems of the Prototype Fast Reactor at the UKAEA Dounreay Reactor Establishment under the following headings - outline of the plant; general requirements; main aspects of the overall system; some particular aspects (data reduction equipment, the automatic protective system, sodium measurements, hydrogen detection in the secondary sodium circuit, temperature measurements, examples of interlock and control logic, cabling and power supplies); and operating experience and possible future developments.

10382 Application of computers in nuclear power stations. Williams, J.R.; Simm, K.J.; Hinze, P. (Atomic Power Constructions Ltd., Sutton (UK)). *J. Inst. Nucl. Eng.;* **18**: No. 3, 74-80(May-Jun 1977).

A description is given of the data processing system at the UK Dungeness B nuclear power station . This system collects and sorts data from the plant and arranges for its display. It also detects abnormalities in the data and gives appropriate warning messages to the operator. The system is also used for the direct digital control of various plant systems on the station. The functions carried out are achieved by a combination of hardware (defined as the equipment which is necessary to fulfil the operating requirements) and software (defined as the essential programs applied in the computer to achieve specified operation of the hardware).

10383 Transients of multi-loop NPP with a fast reactor. Gimmel'shtein, Ya.E.; Greben'kov, Zh.A.; Zatsepin, O.I.; Kotovich, V.V.; Morozov, V.N.; Serebryanaya, V.V. (AN Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 1, 11-15(1977). (In Russian).

Transients of a single-circuit three-loop test-industrial NPP with a gas-cooled fast reactor operating with a dissociating N_2O_4-coolant are considered. The investigations of the plant circuits are presented and temperature changes in the fuel element can, fuel centre and the coolant in the nodal points of the plant operating with partial loadings are shown. On the basis of the performed analysis of the NPP operating conditions a control program is proposed to obtain the best efficiency under all operating conditions at the given limitations on the plant parameters. The comparison of different control methods has shown that the control method of the NPP power change by changing the power of one loop is more economic ally attractive than that of changing the power of all three loops simultaneously. On the basis of the investigations performed an economically attractive method is proposed for the NPP control by changing the power of one loop up to its de-energization, then in the second and the third loops. It is shown that NPP considered has high economic parameters in a wide range of operating conditions.

10384 Control principles for NPP with a dissociating coolant. Pavlin, I.M.; Sharovarov, G.A.; Kamenskaya, Zh.V.; Novosel'skii, A.V.; Banel, E.A. (AN Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 1, 5-10(1977). (In Russian).

The use of a dissociating gas as a coolant and a working substance for NPP enables the realization of a gas-liquid thermodynamic cycle in a single-circuit scheme. A small volume of turbines with a dissociating working substance as opposed to turbines of the same capacity operating on water vapour results in the decrease of inertia moments. Small time constants of warming-up gas volumes and reactor metal mass result in the increase in requirements for response of a number of controllers. The control principles for NPP appear to be substantially different in the presence of a circulating pump with a steep or sloping curve for consumption-head. Various structural schemes of a single-circuit NPP control have been investigated on an analog computer. To find out advantages and disadvantages of fast response systems of frequency control, the investigation of various procedures of frequency control has been performed using: (1) a throttle valve with a pneumatic drive; (2) a hydrolically driven throttle valve; and (3) mechanical or electric ballast loads. The use of a quasi-optimum control law permitting a simultaneous dynamic consideration of a change in the time constant and the gain coefficient of a turbine as well as real dynamics of the drive is one of the ways to increase the fast response of a frequency controller.

10385 Digital load-follow control concept for a nuclear reactor and its simulation for the FRG-2. Chatterjee, A.K. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik; Kiel Univ. (Germany, F.R.). Inst. fuer Reine und Angewandte Kernphysik). *Atomkernenergie;* **29**: No. 3, 202-206(1977). (In German).

In conjunction with the on-line application of the digital computer TR 86 for instrumented test fuel irradiation experiments of the reactor FRG-2 a study has been made with regard to the computer-based nuclear power control along a given power trajectory. This study comprises a derivation of a simplified process model, optimization and estimation of inaccessible state variables along with a hybrid simulation of a resulting control law. The results of this simulation test for the case of the reactor FRG-2 show that the control concept adopted in the study, as for as the short-time transients are concerned, fulfilled the fundamental requirements imposed an such a computer-based power control system.

10386 Optimal control of distributed parameter reactor core by function space method and some numerical experiences. Koga, R. (Kyoto Univ., Uji (Japan). Inst. of Atomic Energy). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 12, 691-700(Dec 1976).

An optimal dynamical control of a linear reactor as a distributed parameter system is obtained numerically along with an analytical expression of the integral equation that should be satisfied by the optimal control. The function space method is employed to derive the equation, and it is known from the numerical experience that only the fundamental of expanding modes is enough to describe the integral kernel of the equation. Space-dependence is collected in the forcing term of the equation. The reactor core model is of two groups of neutrons in steady state and one group of precursors. Two performance functionals are tried. Both are quadratic but one is of the precursor history and the control, whereas another is of the neutron flux density and the control. The latter formulation partly dissolves the weighting problem in the quadratic performance functional.

10387 System of operative computer control of power distribution fields in the Beloyarsk nuclear power plant. Kulikov, N.Ya.; Snitko, E.I.; Rasputnis, A.M.; Solodov, V.P. *At. Energ. (USSR);* **40**: No. 2, 152-154(Feb 1976). (In Russian).

The system of intrareactor control over the reactors of the Byeloyarskaya Atomic Station is described. In the second block of the station, use is made of direct charge emission detectors installed in the central apertures of the superheater channels and operating reliably at temperatures up to 750 deg C. The detectors of the first and the second block are connected to the computer which sends the results of processing the signals to the printer, while the signals for deviations go to the mnemonic tablaux of the reactors. The good working order of the detectors is checked by comparison with zero as well as with the mean detector current for the reactor concerned. The application of the intrareactor control system has allowed the stable thermal power to be increased from 480-500 to 530 Mw and makes it possible to control and maintain the neutron field formed with a relative error of 3-4%. The structural scheme of the system of intrareactor control is given.

10388 Optimum control theory as a basis for designing a nuclear reactor control and safety system. Aleksakov, G.N. *At. Energ. (USSR);* **39**: No. 6, 397-399(Dec 1975). (In Russian).

The problem is considered of applying the theory of relative control in designing control and shield systems (CSS) for nuclear reactors. A systemic approach to designing CSS's is essentially based on an analysis of the interrelationship between the physical processes involved in neutron flux control in the reactor and the specifications of the control system. Reactivity variation rate was shown to unambiguously determine the demands to servomotor power. An analysis of the physical properties of optimum control processes permitted to formulate the technical requirements that approzimate to optimum the operation of a real neutron flux control system. Theoretical conclusions were confirmed by direct experiments on an IRT-2000 reactor by means of a specially devised control system based on a BIR-1 instrument. A comparison of the technical and economical factors of the above system with those of a system based on a BAR-2M instrument indicated that, simultaneously with improving unst unsteady-state processes, consumption and dimensions of the system decreasing by 20 and 5 times respectively. At the same time, the system, as a whole, became simplified and more reliable.

10389 Apparatus for rapidly stopping a reactor. Masamune, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-137090/A/. 23 May 1975. 4p. (In Japanese).

An apparatus is disclosed to move a fuel assembly concentrated in the core to outside of the core to separate the fuel assembly spatially, thereby securely rendering the reactor subcritical. The fuel assembly has its end supported by a fuel support mechanism and is operated by water pressure. In the event the control rod is not inserted as predetermined at the time of rapid stoppage of the reactor, water pressure in the fuel support mechanism for the fuel assembly is released by removing water, and the fuel assembly is moved down by gravity into a fuel guide pipe surrounded by a neutral absorber to render the reactor subcritical thus rapidly stopping the reactor.

10390 Method and apparatus for controlling operation of reactor. Shinpo, K.; Hayashi, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-114593/A/. 2 Apr 1975. 11p. (In Japanese).

A method is disclosedto control power of a reactor according to elongation of fuel rods. Fuel rods arranged in the core of a reactor are provided with fuel-rod-elongation detecting means to control the reactor power on the basis of output signals therefrom.

10391 Power control device in a reactor. Sugiyama, S.; Shibata, Y. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-114592/A/. 2 Apr 1975. 6p. (In Japanese).

A device is disclosed whose purpose is t minimize thermal and nuclear shocks to fuel rods when power of a reactor varies, thereby increasing safety of operation. An power distribution, which is one of the possible calculated results in a core performance calculating system, is introduced to a core flow calculating system to predict an allowable power distribution capable of quickly varying power and to calculate the core flow rate adapted to form a power distribution within the range of the allowable power distribution from said power distribution and present value thereof, the resultant calculated value being delivered to the limiter to control a flow control device so that the power distribution is within the range with the calculated value being the upper limit value of the core flow rate, thereby securing safe operation.

10392 Pressure control device in an atomic power plant. Tanji, J; Kubota, S.; Yanada, S. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-114595/A/. 2 Apr 1975. 6p. (In Japanese).

A device to uniformly provide an optimum control characteristic from low output to high output is disclosed which consists of pressure control device comprising a pipe line for guiding steam generated in a reactor to a turbine, a regulating valve mounted on the pipe line, and an adjuster for compensating at least lead and lag with respect to a deviation between signal for setting vapor pressure within the pipeline and signal for detecting vapor pressure, an opening of the regulating valve being controlled according to output of the adjuster, the improvement including means for correcting lead and lag time of the adjuster by signals according to the output of the reactor.

10393 Control system for emergency core cooling system. Mae, Y. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-111596/A/. 26 Mar 1975. 4p. (In Japanese).

A system is disclosed whose object is too reduce thermal stress produced when the apparatus and ducts constituting the reactor and cooling system are rapidly cooled down at the time of operation of an LMFBR emergency core cooling system. Structure: Decay heat produced from the reactor is led through a primary cooling system and an intermediate heat exchanger to an air cooler for removal, and a rise in reactor output temperature due to decay heat is detected by a detector and compared in a comparator with a signal from a secondary cooling system flow rate detector. The pump of the emergency cooling system is controlled through a PI controller and pump output controller such that heat in a quantity corresponding to the decay heat is supplied to the air cooler according to the difference signal from the comparator. A damper is controlled according to the difference in the signal from a cooler output temperature detector from a preset value and also a difference in the signal from the cooler inlet temperature detector and difference of the signal from a bias setter, whereby the quantity of cooling air supplied to the air cooler is controlled.

10394 Control rod using multi-layer absorber particles. Hirakawa, H. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-108197/A/. 19 Mar 1975. 5p. (In Japanese).

A control rod is disclosed which permits high control efficiency and flattened core output density to be obtained by using multi-layer coated particles consisting of spherical nucleus of an absorbing material covered by low density pyrolytic carbon, nitrided or carbonated metal and high density pyrolytic carbon in the mentioned order. A cross-shaped control rod having four blades is produced by using multi-layer coated particles each consisting of a spherical nucleus of an absorbing material composed of a compound of an oxide, carbide and nitride of an element with a neutron absorption area of no less than 50 barn and covered by buffer layers, namely a low density pyrolytic carbon layer, a metal layer consisting of a member of a group consisting of an oxide, carbide and nitride of a metal having negative free energy during the standard production of standard of the oxide, carbide or nitride and a high density pyrolytic carbon layer.

10395 Method of controlling steam temperature of a fluid heating separation type steam generator. Iwashita, T.; Monta, K. (to Nippon Atomic Industry Group Co. Ltd., Tokyo). Japanese Patent 1976-108196/A/. 19 Mar 1975. 5p. (In Japanese).

A system is disclosed whose object is to keep constant the stability and normal deviation in the entire control system by connecting an element of variable gain substantially in proportion to a preset load in series with the ordinary PID type control system. Changes in steam temperature at an evaporator outlet due to changes in sodium flow rate are detected by a thermocouple. The resultant detection signal is compared with a preset value of the steam generator output temperature, and a portion proportional to the difference between them is added as an operating signal, the operating signal also being used as a sodium flow rate control signal coupled to a sodium flow rate control means. In this method of control of vapor temperature of a fluid heating separation type steam generator, a control gain variable means is connected in series with a temperature control system to obtain control substantially proportional to the preset load.

10396 Method and apparatus for controlling operation of a reactor. Masuda, H. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-104193/A/. 12 Mar 1975. 8p. (In Japanese).

A system is disclosed whose object is to smoothly control operation of a reactor by adequately adjusting density of liquid poison of the reactor. A position of a control rod within a core is detected by a position detector, and a detection signal thereof is fed to an adjusting device to generate a signal for blocking removal of control rod and a signal for blocking insertion thereof. These signals cause a control valve to be opened and closed to flow heavy water containing liquid poison within a calandria tank into a circulating loop through a circulating pump and a cooling device, and the heavy water flown out of the cooling device is partly supplied through a passage to a liquid poison removing device for performance of control.

10397 Control rod. Ozawa, M.; Nishioka, K. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-104194/A/. 12 Mar 1975. 3p. (In Japanese).

To increase useful life of control rods, neutron absorber tube is encased in a package, which is detachably encased in a blade for use. In this way, the neutron absorber tube receives in its upper part irradiation twice that in its lower part, and therefore, the package can be vertically reversed to double the service life.

10398 System for monitoring output distribution in a reactor. Uchikawa, S. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-104195/A/. 10 Mar 1975. 3p. (In Japanese).

A system is disclosed whose purpose is to process signals from a fast neutron detector by means of a computer to obtain output distribution within a reactor, which distribution is displayed and monitored. One fast neutron detector is provided relative to four fuel assemblies. These detection signals are entered in a first operator device to generate a signal of fast neutron flux at a specific position. In a second operator device, a fast neutron flux in the central portion of the fuel assembly is calculated from said signal, and a thermal output signal generated in the fuel assembly is calculated using a diffusion equation. The operator is informed of the analytic result thereof by means of a display device. It is noted that a third operator device calculates the coefficient or the like in the diffusion equation.

10399 Systems for controlling the electric power of a boiling water reactor power station. Fukunishi, K.; Kiyokawa, K. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-101691/A/. 5 Mar 1975. 3p. (In Japanese).

To achieve automatic increase and decrease of electric output in accordance with a predetermined rate of increase or decrease in output when the power output is raised or lowered, an electric output signal from an atomic power plant is led to a differentiating circuit through a smoothing circuit to produce a signal for rate of change of time, and an error signal between this signal and a preset signal produced from a circuit for a preset rate of change of output with time is supplied to an analog adjuster through a limiter. In this way, the flow rate in the reactor core is adjusted by a speed controller to obtain an output of a predetermined rate of increase. The difference signal between the electric output signal and a desired value signal is passed through an absolute circuit to a comparator circuit for comparison with a predetermined threshold value setting signal. The output signal of the comparator is used to operate a relay to open the contact so as to prevent an increase or decrease in the output beyond the required level.

10400 Reactor control systems. Otsuji, N. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-101692/A/. 3 Mar 1975. 8p. (In Japanese).

A system is disclosed whose objects is to alleviate the breakage of fuel rods due to a sudden increase in output density during operation by the provision of means for preventing the withdrawal of a control rod operating at values above a predetermined value. Structure: A control rod is withdrawn by a control rod drive means, and a detection signal is applied as an output from a position measuring means to a position memorizing means in a low output resion for producing and memorizing a control rod pattern for output increase. Thereafter, the prevailing position of the control rod for which an increase in output is demanded is measured by the position measuring means for comparison with the value memorized by the position memorizing means. In this way, when the control rod is withdrawn in excess of the memorized value, an alarm is produced by an operation monitoring means while stopping control rod withdrawal.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 10919, 10974, 11001

10401 (SNV-PM—785E) Concentration of heavy metals in the receiving waters off the nuclear power plants of Sweden. Gustavsson, I. (Statens Naturvaardsverk, Stockholm (Sweden)). Sep 1976. 16p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The concentrations of heavy metals in the water off the nuclear power plants in Sweden in 1975 were normal. Occasional peaks were recorded, but in no case did they reach alarming heights.

10402 Nuclear controversy from the sociological and psychological points of view. Scharioth, J. (Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **22**: No. 6, 338-343(Jun 1977). (In German).

From Reactor congress 1977; Mannheim, Germany, F.R. (29 Mar - 1 Apr 1977).

1 fig.

The nuclear controversy has recently taken a dynamic turn full of tensions. This is particularly true of the FRG where, after many years of continuous speedy development and the erection of the first large commercial power stations, a tough resistance movement of citizens' initiatives, espcially a radical opposition of some groups, has been growing over the past six months. Since the peaceful uses of nuclear energy were first embarked upon in the Federal Republic in the mid-fifties also the economic situation and the wishes and objectives of the working population have undergone major changes. While, in the sixties, most people sought high grade, qualitatively demanding jobs, a wish which was catered to very much by the fundamentally new technology of the utilization of nuclear energy, the two major goals of the working population, i.e., job security and job quality, have meanwhile changed positions on the scale of values.

10403 Development of nuclear power plants in Czechoslovakia and their effect on the living environment. Metke, E.; Novak, S. (Vyskumny Ustav Energeticky, Bratislava (Czechoslovakia)). *Energetika;* **27**: No. 1, 6-11(Jan 1977). (In Slovak).

The envisaged contribution of nuclear power plants to the installed capacity in Czechoslovakia and other industrially advanced countries till 1990 is compared. In Czechoslovakia, the application of reactors of the WWER 440 and WWER 1000 types are envisaged. Their basic characteristics are given and compared to corresponding reactor types operating abroad. The effect is discussed of nuclear power plants on the environment as against conventional power plants. A survey is made of the average annual emission of radioactive gases, aerosols and iodine isotopes related to certain nuclear power plants in the world. The evaluation of radiation load in the neighbourhood of conventional power plants due to ^{226}Ra and ^{228}Ra shows that in conventional power plants of a capacity of 1000 MW the radiation load is about thirty times higher than that in the same capacity WWER nuclear power plants and lower by several orders than in boiling water reactor power plants. According to forecasts till 1990, for the projected nuclear power capacity the average population load in Czechoslovakia will be more than 400 times less than for the same capacity were it covered by conventional power plants.

10404 French ecological movement. Sansen, B. (Electricite de France, 75 - Paris. Direction de l'Equipement). *Rev. Gen. Nucl.;* No. 2, 79-81(1977). (In French).

The analysis of the ecological Movement in France is presented: its organisation, its topics, its position with respect to the main political trends. The accent is put in particular on the antinuclear contestation.

SITING

REFER ALSO TO CITATION(S) 10580

10405 (ORNL/Sub—77-14222/1) ERDA nuclear energy center program. Phase I. Program definition. Final report. (Southern Interstate Nuclear Board, Atlanta, Ga. (USA)). Jun 1977. Contract W-7405-ENG-26. 107p. Dep. NTIS, PC A06/MF A01.

This Phase I report describes the procedures used and the results obtained from a survey of SINB states and major utilities to determine their interest in participating in an ERDA-sponsored study to investigate the technical, economic, and institutional practicality of establishing a potential Nuclear Energy Center at a specific site. The State of South Carolina was the only SINB member to express positive interest in ERDA's Nuclear Energy Center Program, and to offer to submit a proposal through the SINB to select and evaluate a site in South Carolina having the potential for being developed into a Nuclear Energy Center.

RADIOACTIVE EFFLUENTS

REFER ALSO TO CITATION(S) 9783, 9795, 9800

10406 (GSF-S—412) Investigations of the detection of α-radioactivity in samples of effluent water primary circuit and exhaust air of nuclear power plants in the FRG in the years 1973—1975. Hoetzl, H.; Rosner, G.; Winkler, R. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H., Neuherberg/Muenchen (Germany, F.R.). Inst. fuer Strahlenschutz). May 1976. 18p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

Since the middle of 1973 the α-radioactivity of aerosol filters from the stack monitoring system and since the middle of 1974 the α-radioactivity in samples from the primary cycle of the KRB was monitored. Effluent water samples of all nuclear power reactors of the FRG were also examined from the middle of 1973 till 1974. Furthermore, aerosol filters sampled in 1973 and 1974 from various places at the KRB and some aerosol filters from the stack monitoring systems of KWW (1973), KWO (1974) and KKS (1975) were also measured. Essentially, the following procedures of sample preparation for α-spectrometry of the samples in large-area gridded ionization chambers were used: cold ashing of the aerosol samples in 'excited' oxygen; coprecipitation of the alpha emitters from the effluent water samples with iron hydroxide and subsequent cold ashing of the precipitate; evaporation of the samples from the primary cycle on SS plates. The following transuranium nuclides, or some of them, were found in the samples of the primary coolant and in several aerosol filter samples: Pu-239/240, Pu-238 and/or Am-241, Cm-242 and Cm-244. Cm-242 contributes most to the α-radioactivity in fresh samples. In the effluent water samples Cm-242. Pu-239/240 and Pu-238 and/or Am-241 were identified in some cases, in one case also Cm-244. The aim of these investigations is to establish procedures for the measurement and surveillance of α-emitting nuclides in the emissions of power reactors in order to study the contribution of transuranium nuclides to the radiation exposure of the population living in the vicinity of nuclear power stations.

10407 (SSI—1976-038) Summary of personnel doses and discharge of radioactivity at Swedish nuclear power plants 1971-1975. Malmqvist, L.; Persson, Aa. (Statens Straalskyddsinstitut, Stockholm (Sweden)). Jan 1977. 13p. (In Swedish). Dep. NTIS (US Sales Only), PC A02/MF A01.

The report is a summary of personnel doses and activity discharges from Swedish nuclear power plants during the first five years of electric power production by nuclear plants. The personnel doses for the Sweedish plants are lower than the corresponding values for American plants. The highest Swedish value is o,13 manrem per MWE and year. The discharge of radioactivity to the atmosphere from the Swedish plants has been for below the maxi-

mum permissible limits. The discharge of radioactivity to the water recipients was less than 1 % of what is permissible.

10408 Wake and dispersion models for the EBR-II building complex. Halitsky, J. *Atmos. Environ.;* **11**: No. 7, 577-596(1977).

Wind properties measured downwind of the reactor containment structure at the EBR-II complex were found to be in agreement with predictions made with a mathematical wake model that was derived from measurements in the wakes of suspended flat plates in a wind tunnel and modified for the presence of the ground boundary. Simultaneous concentration measurements of a tracer released in the lee of the reactor containment structure were found to be in agreement with the predictions of a mathematical dispersion model that incorporated the wake model in conjunction with atmospheric turbulence properties. The analysis provides insight into the nature and properties of building wakes in the atmosphere, and their influence on dispersion of released material.

10409 Simulation modelling of environmental transport and health consequences of radioactive effluents from nuclear power systems. Cuddihy, R.G.; McClellan, R.O. (Inhalation Toxicology Research Inst., Lovelace Biomedical and Environmental Research Inst., Albuquerque, N. Mex., USA); Chapman, L.D.; Wayland, J.R.; Dugan, V.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). pp 657-666 of In Transuranium nuclides in the environment. Vienna; IAEA (1976).

From Symposium on transuranium nuclides in the environment; San Francisco, Calif., USA (17 - 21 Nov 1975).

Developing programs for widespread production of electrical power from nuclear reactor systems require detailed analyses of anticipated radioactivity releases, environmental contamination and potential impact upon human health. This report describes a simulation model of the environment, including man, developed to study evaluations of risks associated with radioactive releases from nuclear fuel cycle facilities. The model provides predictions of the time-related development of potential health effects in human populations and facilitates the determination of the sensitivity of resulting risk estimates to the many rate constants, physical variables and siting assumptions incorporated into the model. Initial modelling efforts have been directed toward releases of transuranic elements from the Liquid Metal Fast Breeder Reactor fuel cycle including ^{238}Pu, ^{239}Pu, ^{240}Pm, ^{241}Am, ^{242}Cm and ^{244}Cm. Output from the model includes estimates of tumor and genetic defect incidences related to projected growth of nuclear reactor programs through future generations. This information and the sensitivity analyses are directed toward determining the more important model pathways to man and identifying areas of the analysis where fundamental information is lacking.

CHEMICAL AND THERMAL EFFLUENTS

10410 Licence to discharge cooling waters in tidal rivers, examplified by the 'Nuclear Power Station Unterweser'. Kunz, H. (Wasserwirtschaftsamt, Brake/Unterweser (Germany, F.R.)). *Water, Air, Soil Pollut.;* **28**: No. 11, 287-292(Nov 1976). (In German).

8 figs.; 2 tabs.; 9 refs.

Illustrated by the example of the lower Weser, aspects for automatic control, supervision measurements, and measurements for the securing of evidence, all in connection with cooling water discharges, are presented. The particularities of tidal rivers and the conditions for measuring systems resulting therefrom are explained. The cooling water discharge of the Kernkraftwerk Unterweser has been assigned an extensive measurement system for the automatic compilation of hydrologic data. The measurement systems design, the measurement stations, and the central station are described.

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 10202, 10385, 10429, 10469, 10723, 10769

10411 (COO—1560-11) **University of Wisconsin Nuclear Reactor Laboratory, Madison, Wisconsin. Annual report, fiscal year 1976—1977.** Cashwell, R.J. (Wisconsin Univ., Madison (USA). Nuclear Reactor Lab.). 1977. Contract EY-76-C-02-1560. 15p. Dep. NTIS, PC A02/MF A01.

Educational activities involving the use of the University of Wisconsin Nuclear Reactor are reported.

10412 (HEDL-TME—76-46) **FFTF development testing technical progress report, April—June 1977.** Berg, J.D.; Bliss, R.J.; Duckett, A.J.; Duncan, H.C.; Worth, G.A. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1977. Contract EY-76-C-14-2170. 50p. .

Progress in FFTF component development is presented for the following: refueling and plant equipment testing, mechanical equipment testing, reactor components testing, and control and data systems.

10413 (HEDL-TME—76-48) **FFTF development testing technical progress repot, October—December 1976.** Berg, J.D.; Bliss, R.J.; Duckett, A.J.; Duncan, H.C.; Worth, G.A. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Oct 1977. Contract EY-76-C-14-2170. 30p. .

Progress in FFTF development testing is presented for the following: refueling and plant equipment testing, mechanical equipment testing, control and data systems, and reactor components testing.

10414 (HEDL-TME—77-47) **Core engineering technical progress report, April—June 1977.** Peterson, R.E. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1977. Contract EY-76-C-14-2170. 64p. .

Progress in FFTF core development is presented for the following study areas: core physics, radiation and shield analysis, and core design.

10415 Calculations of void streaming in the Argonne gas-cooled fast reactor critical experiments. Gelbard, E.M.; Wade, D.C.; Schaefer, R.W.; Phillips, R.E. (Argonne National Lab., IL). *Nucl. Sci. Eng.;* **64**: No. 2, 624-637(Oct 1977).

A validation procedure for and results of streaming calculations are described for the Argonne National Laboratory gas-cooled fast reactor critical assemblies. The calculational approach for evaluating anisotropic diffusion theory methods is discussed in the context of a broader validation effort. A tentative procedure for converting from the three-dimensional physical unit cell to a one-dimensional model and for the generation of Benoist anisotropic diffusion coefficients in this one-dimensional model is described and analyzed. Based on the results, an alternate one-dimensional model and an alternate anistropic diffusion coefficient prescription are developed. After evaluating the alternate procedure, conclusions are drawn from the study.

10416 Extraction of ultracold neutrons from high flux reactor SM-2. Kosvintsev, Yu.Yu.; Kulagin, E.N.; Kushnir, Yu.A.; Morozov, V.I.; Strelkov, A.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). *Nucl. Instrum. Methods;* **143**: No. 1, 133-137(15 May 1977).

The present paper describes the installation for ultracold neutrons (UCN) at the SM-2 reactor of the Reactor Research Institute in Dimitrovgrad. Maximum UCN flux extracted was about 1200 s^{-1}. Both integral and differential energetic spectra of the obtained beam were measured. The UCN transmission was determined for straight and bent guide tubes as well as the angular distribution of UCN at the exit of these guide tubes. It is shown that there exists an effect of beam alignment and a lower limiting angle in the neutron angular distribution at the guide tube exit. Results of a storage experiment in a vessel of about 340 l are reported.

10417 Stress analysis of a nuclear reactor grid plenum assembly and its application to the EBR-II. Chang, L.K.; Marchertas, A.H. (Argonne National Lab., Ill. (USA)). *Nucl. Eng. Des.;* **24**: No. 3, 387-397(May 1977).

A structural model is presented to predict the stress and deformation of a nuclear reactor grid plenum assembly. The model consists of two circular grid plates on top of one another which are interconnected by a large number of tubes, a perforated cylindrical shell and a cylinder at the outer edge of the plates. During normal reactor operation and shutdown the grid plenum assembly is subjected to both external and internal loads, in which the external load is due to the dead weight of the subassemblies resting on the upper grid plate and the coolant pressure, while the internal load is due to the temperature gradient and irradiation swelling in the grid plates accumulated through the life of the reactor. The structure is divided into many annular regions implying an axisymmetric treatment. The solution of the structural system is obtained by solving the equilibrium equations of the individual tubes, plates and shells, and satisfying the compatability condition at the boundary of each region. The swelling strain in the grid plates is treated analogously to that of thermal strain in the elastic region. The numerical results of the problem are obtained by means of a computer code which uses a matrix-inversion technique to solve the simultaneous algebraic equations involved.

10418 Reactor primary coolant flow rate determination from observation of the ratio of gamma to neutron radiation levels near the primary line. Chabot, G.E.; Glass, B.; Delizza, C. (Lowell Univ., Mass. (USA)). *Health Phys.;* **32**: No. 5, 397-401(May 1977).

Routine operations and health physics measurements at a research reactor commonly include monitoring of gamma and neutron radiation levels in the coolant pump room area. Gamma fields are heavily weighted by emissions from 7.1 sec. ^{16}N and neutron

levels are commonly attributed to 4.1 sec ^{17}N decay. For a fixed flow rate measurements of either gamma or neutron levels made at a particular point downstream from the core are indicative of a particular power level. The work described here demonstrates the use of the ratio of gamma to neutron measurements as a quantitative indicator of primary coolant flow rate. The quantities of ^{16}N and ^{17}N present at a particular location in the primary coolant line are dependent on in core coolant irradiation time and the time required for coolant to move from the core to the monitoring point. Since ^{16}N and ^{17}N have appreciably different half lives variations in coolant flow rate will affect the quantities of each species present at a particular location such that the ratio of the gamma (^{16}N) to neutron (^{17}N) measurement also changes. The ratio is constant, independent of power level for a fixed flow rate, but varies smoothly with increasing or decreasing flow rate over a range of interest; it can thus serve as a secondary measurement of the important operating parameter, primary coolant flow rate.

10419 Installation for the irradiation of large silicon monocrystals for the production of power thyristors. Krull, W.; Martens, P. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Zentralabteilung Forschungsreaktoren). *Kerntechnik;* **19**: No. 3, 131-135(Mar 1977). (In English, German).

An irradiation installation for Si monocrystals with diameters up to 61 mm and lengths up to 120 mm is described. The homogeneity of the thermal neutron flux density is better than 5%; the fluence is also adjustable with a relative error below 5%. Almost 1000 Si samples having been irradiated the experience with this irradiation installation is reported.

10420 Measurement of large asymptotic reactor periods from about 10^3 to 4.10^4 sec) to determine reactivity effects of small samples. Grinevich, F.A.; Evchuk, A.I.; Klimentov, V.B.; Tyzh, A.V.; Churkin, Yu.I.; Yaroshevich, O.I. (AN Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 1, 16-21(1977). (In Russian).

All investigation programs on fast reactor physics include measurements of low reactivity values $(1\text{-}0.01)x10^{-5}$ $\Delta K/K$. An application of the pile oscillator technique for the purpose requires a special critical assembly for an installation of the oscillator. Thus it is of interest to develop relatively simple methods. In particular, one such method is the asymptotic period method which is widely used for low reactivity measurements. The description of the method and equipment developed for low reactivity measurements according to the measurements of the steady-state reactor period is presented. The equipment has been tested on the BTS-2 fast-thermal critical assembly. Measurement results on the reactivity effects of small samples in the fast zone centre are given. It is shown that the application of the method of measuring long steady-state periods and developed and tested equipment enables the reactivity of $(1+\text{-}0.02)x10^{-5}$ $\Delta K/K$ to be determined at the critical assembly power of 5 to 10 Wt. The disadvantage of the method presented is the time lost on reaching the steady-state period which results in greater sensitivity of the method to reactivity drifts.

10421 Reactor dosimetry using TLD and Rh activation techniques. Gomaa, M.A.; Sayed, A.M.; Eid, A.M.; El Kolaly, M.A. (Atomic Energy Establishment, Cairo (Egypt). Nuclear Research Centre). *Atomkernenergie;* **29**: No. 3, 225-227(1977).

Radiation measurements around a vertical channel of the EY-RR-1 reactor are carried out using TLD materials and the Rh-activation technique is also examined. For γ-ray measurements Li 7 F, Inshas sand and plate glass are used. For thermal neutrons $Li_2B_4O_7$-tablets are used. Experimental results indicated that Li 7 F; Inshas and plate glass are useful for γ-ray measurements and $Li_2B_4O_7$ for thermal neutron measurements. Radiation effect and nuclear heating are also studied.

10422 About the high pressure and high temperature reactor loop to be constructed in the Training Reactor of the Budapest Technical University. Csom, Gy.; Kocsis, E. (Budapesti Muszaki Egyetem (Hungary). Egyetemi Reaktor); Farkas, D.; Angyal, I.; Szabo, M. (Budapesti Muszaki Egyetem (Hungary)). *Engei Gakkai Zasshi;* **29**: No. 9, 412-415(1976). (In Hungarian).

The possibilities of the construction of an experimental reactor loop to be used within a pressure limit of 100 at and a temperature limit of 300 deg C are described. The data needed to the compilation of the preliminary technical project on the loop are presented. The arrangement, the technical flow-diagram, the description of all elements belonging to the loop (as units of the system) with their main dimensions and characteristical data are included. The measuring places, the function of the loop and its necessary instrumentation as well as thermoradiological experiments to be carried out with the loop are also presented.

PLUTONIUM AND ISOTOPE PRODUCTION REACTORS

10423 Method for generating neutronic data bases for transient reactor calculations. Buckner, M.R.; Parks, P.B. (Savannah River Lab., Aiken, SC). *Nucl. Sci. Eng.;* **64**: No. 2, 539-551(Oct 1977).

A systematic method has been developed for the construction of neutronic data bases used with the GRASS code in the analyses of postulated transients in Savannah River Plant (SRP) reactors. In this context, a neutronic data base consists of a set or sets of correlation equations that represent the few-group macroscopic cross sections for various cell types in the reactor charge. The cross sections are functions of the reactor state variables (temperatures, densities, material compositions, etc.). To minimize the size of the data set library required to support the correlations, two steps are taken. First, the state variables are grouped into separate correlations, or "regimes." A state variable is assigned to a particular regime according to the relative magnitude of the reactivity perturbation caused by changing the value of the variable over its allowed range. The separate regime correlation equations are combined linearly within GRASS to produce a single set of few-group cross sections for each cell type at any time within the transient. The second step involves the use of Box-Behnken or other incomplete factorial data library designs to support each regime correlation. The derivation of the regime correlation equations is performed with the CRASS system of codes. The methods are demonstrated by application to the design of a transient data base for a typical SRP reactor charge. Transient phenomena included are the temperature feedback of normal reactor operation, coolant flow instability, assembly melting with associated entrainment of melted particles in the moderator, moderator boiling, and gadolinium poison injection.

PROPULSION REACTORS

REFER ALSO TO CITATION(S) 11217

10424 (CONF-760646—, pp 211-216) **Magnetoplasmadynamic thruster applications.** Pawlik, E.V. (Jet Propulsion Lab., Pasadena, CA). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

Advance study activities within NASA indicate that electric propulsion will be required to make certain types of potential missions feasible. The large power levels under consideration make magnetoplasmadynamic thrusters a good candidate for these applications since this type of electric thruster is best suited to operation at high power levels. The status of the magnetoplasmadynamic thruster is examined and compared to the ion thruster which also is a candidate. The use of these two types of electric propulsion devices for orbit raising of a self-powered large satellite is examined from a cost standpoint. In addition the use of nuclear electric propulsion is described for use as both a near-earth space tug and for an interplanetary exploration vehicle. These preliminary examinations indicate that the magnetoplasmadynamic thruster is the lowest cost thruster and therefore merits serious consideration for these applications.

10425 (CONF-760646—, pp 217-223) **Mini-cavity plasma core reactors for dual-mode space nuclear power/propulsion systems.** Chow, S. (Princeton Univ., NJ). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

A mini-cavity plasma core reactor is investigated for potential use in a dual-mode space power and propulsion system. In the propulsive mode, hydrogen propellant is injected radially inward through the reactor solid regions and into the cavity. The propellant is heated by both solid driver fuel elements surrounding the cavity and uranium plasma before it is exhausted out the nozzle. The propellant only removes a fraction of the driver power, the remainder is transferred by a coolant fluid to a power conversion system, which incorporates a radiator for heat rejection. In the power generation mode, the plasma and propellant flows are shut off, and the driver elements supply thermal power to the power conversion system, which generates electricity for primary electric propulsion purposes.

NUCLEAR SHIPS LICENSING AND REGULATION

10426 (CONF-760646—, pp 123-135) **Review of coaxial flow gas core nuclear rocket fluid mechanics.** Weinstein, H. (Illinois Inst. of Tech., Chicago). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

In a prematurely aborted attempt to demonstrate the feasibility of using a gas core nuclear reactor as a rocket engine, NASA initiated a number of studies on the relevant fluid mechanics problems. These studies were carried out at NASA laboratories, universities and industrial research laboratories. Because of the relatively sudden termination of most of this work, a unified overview was never presented which demonstrated the accomplishments of the program and pointed out the areas where additional work was required for a full understanding of the cavity flow. This review attempts to fulfill a part of this need in two important areas.

REACTOR SAFETY

REFER ALSO TO CITATION(S) 10919

10427 (ANL-AFP—1) **Advanced Fuels Program. Quarterly progress report for the period, July—September 1974.** Kittel, J.H. (comp.). (Argonne National Lab., Ill. (USA)). 1974. Contract W-31-109-ENG-38. 136p. .

Progress is summarized in the following LMFBR mixed carbide and mixed nitride fuel development tasks: (1) fuel system design studies; (2) fuel element modelling; (3) steady state irradiations; (4) off-normal irradiations; (5) fuel properties; (6) reprocessing; and (7) safety.

10428 (ANL-CT—78-3) **Numerical results obtained from the three dimensional transient single phase version of the COMMIX computer code.** Domanus, H.M.; Schmitt, R.C.; Sha, W.T. (Argonne National Lab., Ill. (USA)). Oct 1977. Contract W-31-109-ENG-38. 103p. (NUREG—0355). Dep. NTIS, PC A06/MF A01.

Results from the first three applications of the three-dimensional, transient, single-phase version of the thermal-hydraulics computer code, COMMIX, are presented. The applications include an LMFBR outlet plenum, a horizontal pipe, and a 19-pin LMFBR hexagonal fuel assembly. Each case is described and the results presented. All three applications use liquid sodium as the fluid. The plenum and pipe analyses are transient, while the fuel assembly involves a steady-state analysis.

10429 (ANL-RDP—62) **Reactor development program progress report, July—August 1977.** Sachs, R.G.; Kyger, J.A. (Argonne National Lab., Ill. (USA)). 5 Oct 1977. Contract W-31-109-ENG-38. vp.

Progress is summarized in the following research and development areas: Experimental Breeder Reactor No. II (EBR-II), LMFBR Design Support, Instrumentation and Control, Reactor Physics, Reactor Safety, and Other Fast Breeder Reactors.

10430 (AWRE—49/91/87) **Computer code for SEURBNUK-2 for fast reactor explosion containment safety studies.** Cameron, I.G.; Hankin, B.C.; Warham, A.G.P.; Benuzzi, A.; Yerkess, A. (UKAEA Weapons Group, Aldermaston. Atomic Weapons Research Establishment; Commission of the European Communities, Ispra (Italy). Joint Research Centre). May 1977. 26p. (TRG-Report—3006(R/X); JRC-ISPRA-ET—02/77). Dep. NTIS (US Sales Only), PC A03/MF A01.

The SEURBNUK-2 code has been developed jointly by JRC, Ispra and AWRE, Aldermaston for use in containment analysis for fast reactor safety studies. It is a major extension of the SURBOUM code developed earlier by Belgonucleaire and Aldermaston, which, in turn, was based on the Marker and Cell (MAC) code. In the Marker and Cell method the motion of a two-dimensional incompressible fluid, which may have a free surface, is solved using an Eulerian approach whereby the fluid moves through a fixed grid of mesh lines with velocity and pressure as the basic variables. Massless particles are distributed throughout the fluid and move with it, but their sole use is to determine which cells contain fluid. The numerical procedures adopted in SEURBNUK to solve the basic hydrodynamic equations are similar to the ICE procedure which itself is an extension of the MAC method. In this the non-linear partial differential equations are solved by an implicit finite difference technique which advances the solution in a series of time steps. SEURBNUK-2 has a full thin shell treatment for tanks of arbitrary shape and includes the effects of compressibility of the fluid. A feature of SEURBNUK is that the equations of motion for the thin shells are solved quite separately from those for the fluid and the time step for the fluid flow calculation is an integral multiple of that for calculating the shell motion. The interaction of the shell with the fluid is then considered as a modification to the coefficients in the implicit pressure equations, the modification naturally depending on the behavior of the thin shell section within the fluid cell.

10431 (CONF-770807—46) **Response of subassembly model with internals.** Kennedy, J.M.; Belytschko, T. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 23p. Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, California, USA (15 Aug 1977).

Analytical tools have been developed and validated by controlled sets of experiments to understand the response of an accident and/or single subassembly in an LMFBR reasonably well. They have been subjected to a variety of loadings and boundary environments. Some large subassembly cluster experiments have been performed, however little analytical work has accompanied them because of the lack of suitable analytical tools. Reported are analytical approaches to: (1) development of more sophisiticated models for the subassembly internals, that is, the fuel pins and coolant; (2) development of models for representing three dimensional effects in subassemblies adjacent to the accident subassembly. These analytical developments will provide feasible capabilities for doing economical three-dimensional analysis not previously available.

10432 (CONF-771108—3) **Evaluations of CRBRP thermal margin beyond the design base.** Schornhorst, J.R.; Strawbridge, L.E.; Bradbury, P. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). 1977. Contract EY-76-C-15-2395. 10p. Dep. NTIS, PC A02/MF A01.

From Post accident heat removal information exchange meeting; Chicago, Illinois, USA (2 Nov 1977).

The thermal loads and radiological consequences that could result from a hypothetical core disruptive accident with whole core involvement were evaluated. Since the in-vessel margins may not prevent melt-through of the reactor vessel and guard vessel, emphasis has been placed on providing margins external to the reactor vessel and guard vessel to mitigate the radiological consequences of an HCDA. To evaluate the plant thermal and radiological margins, the release of the entire core, blankets and primary sodium into the reactor cavity was considered. Design requirements have been placed on plant components and structures to assure that containment integrity can be maintained without venting for at least 24 hours. Features are also included to provide long term mitigation of HCDA consequences. Based on the thermal and radiological evaluations considering the CRBRP features it is concluded that the radiological consequences of a hypothetical core disruptive accident would be enveloped by those for light water reactors for events beyond the design base.

10433 (EPRI-NP—160(Vol.1)) **1/3 scale air—water pump program, analytical pump performance model. Volume 1. Key phase report.** Cudlin, J.J. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Oct 1977. 66p. Dep. NTIS, PC A04/MF A01.

A model for reactor coolant pump performance during two-phase flow is described. The model is based on steady-state tests of a one-third-scale reactor coolant pump using air-water flows. The single- and two-phase homologous curve parameters calculated from the test data are related through multiplier functions of the pump average void fraction. The air-water head and torque multipliers are implemented in a homologous curve model for transient reactor coolant pump behavior.

10434 (EPRI-NP—170) **Analytical models and experimental studies of centrifugal pump performance in two-phase flow. Key phase report.** Wilson, D.G.; Chan, T.C.; Goldfinch, A.L.; Zegley, R.D. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Mechanical Engineering). Jan 1977. 182p. Dep. NTIS, PC A09/MF A01.

The existing available models of the performance of centrifugal pumps operating with two-phase flow are reviewed. A new method of modeling the two-phase performance of pumps is proposed and given preliminary evaluation. Change in enthalpy or head across the pump rotor is given by the Euler equation and losses in two-phase flow are shown to be principally a function only of losses in single-phase flow at the same flow coefficient, of the flow coefficient itself, and of the void fraction and flow regime at pump inlet. The correlating curves so obtained for three pumps have shown similarities, giving a fair promise that the performance of any pump will be predictable with the choice of one correlating curve from a comparatively small family of curves. The parameter which will be most likely to relate the family to a particular pump is the pump's peak efficiency in single-phase flow. The model correlates the data from different pump tests in all four quadrants. Some of these two-phase data were taken on a small air-water test rig in order to study the effects of changing flow regimes on pump performance. A mechanism by which a pump operating in the first quadrant can operate in a high-loss, stable manner through the migration of gas or vapor bubbles upstream from rotor outlet to rotor inlet through the action of the intense centrifugal field and remain blanketing the rotor even after the inlet flow returns to the fully liquid condition was identified.

10435 (EPRI-NP—446) **SUNYAB/EPRI combined injection ECCS program. Facility description; key phase report.** Chon, W.Y.; Liao, N.S.; Addabbo, C.; Thomsen, O.J.; Chun, M.H.; Ormsby, D. (State Univ. of New York, Buffalo (USA)). Jul 1977. 108p. Dep. NTIS, PC A06/MF A01.

One of the primary objectives of SUNYAB/EPRI Combined Injection ECC Program is to experimentally investigate the combined top and bottom injection emergency core cooling and reflood phenomena that could occur in a simulated PWR configuration after a hypothetical loss-of-coolant accident (LOCA). The system design requirements based on the above objective are established and the results of detailed facility design are presented. Test parameters and their ranges are then defined and the test plan for the first phase of the investigation is tabulated. The detailed drawings of facility components and computer programs developed in conjunction with the operation of the facility are given in the appendices.

10436 (EURFNR—1454) **Sodium boiling experiments in an annular test section under flow rundown conditions.** Kaiser, A.; Peppler, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung). Mar 1977. 44p. (KFK—2389). Dep. NTIS (US Sales Only), PC A03/MF A01.

Work performed under United States—Euratom Fast Reactor Exchange Program.

Experiments have been carried out using sodium in an annular test section geometry to simulate boiling development in a fast reactor core under the somewhat improbable conditions of primary circulator pump run-down with coincidental failure of the reactor trip system. Induction heating of the outer tube was used, the axial heat flux distribution being linear. Boiling was achieved by means of a steady reduction of the coolant flow from normal steady state values, heat fluxes being appropriate to reactor conditions. Boiling was allowed to continue until indications of permanent dryout of the heated tube were received, at which stage power was terminated to prevent damage to the test section. The results obtained provide useful information on the transient development of boiling, the axial distribution of void within the channel, initial superheat, liquid film thickness, dryout and rewetting. The experiments thus provide a source of data against which computer codes such as BLOW3 based on theoretical models of boiling may be validated.

10437 (EURFNR—1464) **Analysis of experimental fission gas behavior data in fast reactor fuel under steady state and transient conditions.** Fischer, E.A. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). Jun 1977. 35p. (KFK—2370). Dep. NTIS (US Sales Only), PC A03/MF A01.

Work performed under United States—Euratom Fast Reactor Exchange Program.

To assess the utility of the computer programs LANGZEIT and KURZZEIT for the prediction of the fission gas behavior in LMFBR accident analysis, the input parameters were reassessed, a systematic comparison of the results with experimental data was carried out, and the model was further developed to include the diffusion of gas bubbles in a thermal gradient. The empirical relation by Dutt was used for a comparison of the predicted gas release with experimental data. In addition, a comparison with data obtained in the fuel irradiation program of the Debenelux Fast Breeder Project was also carried out. The LANGZEIT results obtained using the new input parameters are consistent with experimental data for burn up values above 20,000 MWd/to. For lower burn up, LANGZEIT overestimates the gas release, because it considers the gas at grain boundaries as released. (An improved model is now available.) The program KURZZEIT was used to analyze transient gas release laboratory experiments carried out at HEDL. For this purpose, the effect of bubble diffusion in a thermal gradient had to be included in the model, because it plays an important role in those experiments. If reasonable values for the bubble diffusion coefficient are used, the model predicts correctly the time needed until complete gas release in the HEDL experiment, but not the details of the release history.

10438 (GA-A—14336) **HTGR risk assessment study.** Joksimovic, V.; Houghton, W.J.; Emon, D.E. (General Atomic Co., San Diego, Calif. (USA)). Jul 1977. Contract EY-76-C-03-0167-051. 28p. (CONF-770625—4). Dep. NTIS, PC A03/MF A01.

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, Tennessee, USA (20 Jun 1977).

The Accident Initiation and Progression Analysis (AIPA) Study being performed for the high-temperature gas-cooled reactor (HTGR) utilizes methods of probabilistic risk assessment similar to those used in the Reactor Safety Study (WASH-1400). Analytical methods are employed for the treatment of common cause failures involving human errors and other dependencies in redundant systems. The original objective of the AIPA study was to provide guidance for safety research and development programs for HTGRs. Core heatup events appear to be relatively important though the risk from such accidents in the HTGR is found to be low. Plateout and fission product transport within the prestressed concrete reactor vessel (PCRV) during core heatup rank high as important subjects for safety research and development to confirm the degree of retention of fission products. Conclusions about the relative and, in particular, absolute safety of HTGRs are being reached with care. Results of the study to date provide a reasonable and strong indication that the HTGR has excellent relative and promising absolute safety characteristics because of its inherent safety features that reduce the potential for fission product release.

10439 (GRS-F—35) **Reports on the research projects in the field of reactor safety sponsored by the Federal Ministry for Science and Technology. Period under report: October 1—December 31, 1976.** (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.)). Mar 1977. 462p. (In German). Dep. NTIS (US Sales Only), PC A20/MF A01.

Investigations on the safety of Light Water Reactors (LWR) being performed in the framework of the safety program 'Reactor Safety' are sponsored by the Bundesminister fuer Forschung und Technologie (BMFT - Secretary of State for Research and Technology). Objective of this program is to continue improving the safety of LWRs, in order to minimize the risk for the environment. With grant assistance from the Bundesminister des Innern (BMI - Secretary of State for Home Affairs) research contracts in the field of reactor safety are being performed. Results of these projects should contribute to resolving questions arising from nuclear licensing procedures. The Forschungsbetreuung (FB - research supervision department) at the Institute for Reactor Safety (IRS), as consultants to BMFT and BMI, provides information about the progress of investigations. Individual reports will be prepared and put into standard forms by the research contractors. Each report gives information on: 1) the work accomplished, 2) the results obtained, 3) the work planned to be continued. Initial reports of research projects describe in addition the purpose of the work. A BMFT-research program on the safety of Fast Breeders (Schneller Brutreaktor - SBR) is presently under discussion. In order to define several problems, investigations included in the present compilation (RS 139, 140, 143, 162) will be previously performed.

10440 (LA-UR—77-1993) **Fission product release into the primary coolant.** Apperson, C.E. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 11p. (CONF-770929—4). Dep. NTIS, PC A02/MF A01.

From Seminar on HTGR safety technology; Upton, New York, USA (15 Sep 1977).

The analytic evaluation of steady state primary coolant activity is discussed. The reported calculations account for temperature dependent fuel failure in two particle types and arbitrary radioactive decay chains. A matrix operator technique implemented in the SUVIUS code is used to solve the simultaneous equations. Results are compared with General Atomic Company's published results.

10441 (NUREG—0286) **Study of the reactivity effect of bubble collapse in molten liquid metal cooled reactors.** Munno, F.J.; Sheaks, O.J. (Maryland Univ., College Park (USA). Dept. of Chemical and Nuclear Engineering). Aug 1977. 60p. NTIS $4.50.

The reactivity effect of void collapse on a Core Disruptive Accident in a sodium free fast reactor core was studied. A two-dimensional transport theory computer code was employed to obtain a reactivity model which incorporated random distributions of voids in spatial location and bubble size. This model was implemented into VENUS-II and several excursions were investigated for the purpose of assessing the effect of bubble collapse reactivity on excursion energy. In addition, comparisons were made between the VENUS-II results obtained using the transport reactivity model and those obtained using a reactivity model developed from the Behrens' formulation of the leakage effects due to the presence of bubbles. The results indicate that excursion energy is sensitive to the shape of the reactivity versus void fraction function and that reactivity models based strictly on leakage effects are probably conservative compared to models which include both self-multiplication and leakage.

10442 (ORNL/TM—5680) **Safety status of HTGR structural ceramics.** Wei, G.C.; DiStefano, J.R. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 31p. Dep. NTIS, PC A03/MF A01.

The objective of this study is to assess the safety status of structural ceramics proposed for use in an HTGR. In this report the mechanical and physical properties of the proposed structural ceramics are reviewed, and the current design and material specifications are discussed. Potential safety problem areas are identified. Analytical models for creep deformation, devitrification, compatibility, fatigue, and thermal insulation stability are based on published work in the literature. The predictions made are generally based upon extrapolations to HTGR conditions. The data indicate that creep deformation in silicon nitride and alumina ceramics is acceptable if the purity and composition are properly controlled. Devitrification and creep in fused silica used in the core support structure and the thermal barrier system could be excessive. Thermodynamic data

indicate that silicon nitride will be incompatible with the graphite seat used in the design. Under normal reactor operating conditions, or during start-up and shutdown, static fatigue and thermal shock effects in all three members of the core support structural ceramics could cause reductions in safety factors.

10443 (TREE-NUREG—1150) **Experiment data report for Semiscale Mod-1 test S-28-3 (steam generator tube rupture test).** Gillins, R.L.; Sackett, K.E. (EG and G Idaho, Inc., Idaho Falls (USA)). Oct 1977. Contract EY-76-C-07-1570. 286p. Dep. NTIS, PC A13/MF A01.

Recorded test data are presented for Test S-28-3 of the Semiscale Mod-1 steam generator tube rupture test series. These tests are among several Semiscale Mod-1 experiments conducted to investigate the thermal and hydraulic phenomena accompanying a hypothesized loss-of-coolant accident in a pressurized water reactor (PWR) system. Test S-28-3 was conducted from initial conditions of 15621 kPa and 555 K to investigate the response of the Semiscale Mod-1 system to a depressurization and reflood transient following a simulated double-ended offset shear of the broken loop cold leg piping. During the test, cooling water was injected into the cold leg of the intact and broken loops to simulate emergency core coolant injection in a PWR. Twelve steam generator tube ruptures were simulated by a controlled injection from a heated accumulator into the intact loop hot leg.

10444 (UCLA-ENG—7528) **Effect of a certain class of potential common mode failures on the reliability of redundant systems.** Apostolakis, G.E. (California Univ., Los Angeles (USA). Dept. of Energy and Kinetics). Nov 1975. 38p. of California, Los Angeles.

This is a theoretical investigation of the importance of common mode failures on the reliability of redundant systems. These failures are assumed to be the result of fatal shocks (e.g., from earthquakes, explosions, etc.) which occur at a constant rate. This formulation makes it possible to predict analytically results obtained in the past which showed that the probability of a common mode failure of the redundant channels of the protection system of a typical nuclear power plant was orders of magnitude larger than the probability of failure from chance failures alone. Furthermore, since most reliability analyses of redundant systems do not include potential common mode failures in the probabilistic calculations, criteria are established which can be used to decide either that the common-mode-failure effects are indeed insignificant or that such calculations are meaningless, and more sophisticated methods of analysis are required, because common mode failures cannot be ignored.

10445 (WCAP—8709/A) **MULTIFLEX: Fortran-IV computer program for analyzing thermal—hydraulic—structure system dynamics.** Takeuchi, K.; Kowalski, D.J.; Esposito, V.J.; Bordelon, F.M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). PWR Systems Div.). Sep 1977. vp. Electric Corp., Pittsburgh, PA.

Responses to questions raised by the Nuclear Regulatory Commission in their evaluation of the MULTIPLEX code are presented.

10446 Mathematical and computational techniques employed in the deterministic approach to liquid-metal fast breeder reactor safety. Waltar, A.E. (Univ. of Virginia, Charlottesville); Padilla, A. Jr. *Nucl. Sci. Eng.;* **64**: No. 2, 418-451(Oct 1977).

The paper reviews major computer code packages presently utilized or under active development in the U.S. for deterministic liquid-metal fast breeder reactor safety analysis. Although the review covers the very large accident domain from intact predisassembly geometry through radiological consequences, an attempt was made to categorize code systems according to the physical problems solved to provide a working orientation for those not intimately involved in the field. Mathematical and computational aspects were given particular focus in the hope of stimulating development of more efficient numerical approaches in those areas of greatest need.

10447 Probabilistic fast reactor accident analysis. Ott, K.O. (Purdue Univ., West Lafayette, IN). *Nucl. Sci. Eng.;* **64**: No. 2, 452-464(Oct 1977).

An approach for the description and evaluation of the uncertainties in the predicted consequences of fast breeder reactor accidents is outlined. All uncertainties are viewed as uncertainties of parameters, either of physical parameters or of quantities that appear in the parameterization of phenomenological models. By the incorporation of parameter uncertainties in the simulation of the accident progression, single accident-path scenarios assume the character of "accident spectra." The progression of accident spectra is found by combining deterministically calculated accident-path results with the probability of the respective set of input parameters. The substantial method development needed for the implementation of the approach is discussed, and the status of the development is briefly reviewed. Typical results are presented for illustration purposes. The possible eventual significance of the approach is indicated.

10448 Numerical model of reactor fuel and coolant motions following pin failure. Pizzica, P.A.; Abramson, P.B. (Argonne National Lab., IL). *Nucl. Sci. Eng.;* **64**: No. 2, 465-479(Oct 1977).

From Proceedings of the international meeting on fast reactor safety and related physics; Chicago, IL, USA (Oct 1976).

The computer code EPIC models fuel and coolant motion that results from internal fuel pin pressure (from fission gas or fuel vapor) and/or from the generation of sodium vapor pressures in the coolant channel subsequent to pin failure in a liquid-metal fast breeder reactor. The modeling includes the ejection of molten fuel from the pin into a coolant channel with any amount of voiding through a clad rip which may be of any length or which may expand with time. One-dimensional Eulerian hydrodynamics is used to model both the motion of fuel and fission gas inside a molten fuel cavity and the mixture of two-phase sodium and fission gas in the channel. Motion of molten fuel particles in the coolant channel is tracked with a particle-in-cell technique.

10449 Simulation of transients in liquid-metal fast breeder reactor systems. Agrawal, A.K.; Guppy, J.G.; Madni, I.K.; Quan, V.; Weaver, W.L. III; Yang, J.W. (Brookhaven National Lab., Upton, NY). *Nucl. Sci. Eng.;* **64**: No. 2, 480-491(Oct 1977).

The transient simulation of a liquid-metal fast breeder reactor (LMFBR) plant requires (a) modeling of all processes that may be encountered and (b) the development of numerical methods to solve them. All models needed for the thermohydraulic simulation of the whole plant are formulated. Numerical techniques required to solve the governing equations, which are hyperbolic and parabolic partial-differential equations and ordinary differential equations, are examined. It appears that the implicit (or partially implicit) scheme is most suitable to meet both the stability and accuracy requirements. A new approach, labeled as the multistep scheme, to efficiently solve the entire system is then presented and illustrated through an example. For a simplified test problem, the multistep scheme has been found to be more efficient (by a factor of 2 to 3) than the commonly used single-step methods. This effort has resulted in the creation of a system transient simulation code, called SSC, for LMFBRs.

10450 Technical diagnostics - equipment monitoring for increasing safety and availability of nuclear power plants. Sturm, A.; Foerster, R. (Ingenieurhochschule Zittau (German Democratic Republic). Sektion Kraftwerksanlagenbau und Energieumwandlung). *Kernenergie;* **20**: No. 8, 233-238(Aug 1977). (In German).

Utilization of technical diagnostics in equipment monitoring of nuclear power plants for ensuring nuclear safety, economic availability, and for decision making on necessary maintenance is reviewed. Technical diagnostics is subdivided into inspection and early detection of malfunctions. Moreover, combination of technical diagnostics and equipment monitoring, integration of technical diagnostics into maintenance strategy, and problems of introducing early detection of malfunctions into maintenance management of nuclear power plants are also discussed. In addition, a compilation of measuring techniques used in technical diagnostics has been made. The international state of the art of equipment monitoring in PWR nuclear power plants is illustrated by description of the sound and vibration measuring techniques.

10451 Tests in support of LMFBR. Abrahamson, G.R.; Cagliostro, D.J.; Florence, A.L. (Stanford Research Inst., Menlo Park, Calif. (USA)). *Nucl. Eng. Des.;* **42**: No. 1, 89-104(Jun 1977).

From International seminar on Containment of Fast Breeder Reactors; San Francisco, USA (22 - 23 Aug 1977).

Tests in support of LMFBR projects for potential incidents involving a hypothetical core disruptive accident or sodium-water interactions in steam generators have two possible goals: (1) to evaluate the integrity of the primary containment after the design is frozen or (2) to investigate design options in support of primary containment design. The test planning approach differs depending on the goal. The Fast Flux Facility tests had the first goal, the current Clinch River Breeder Reactor tests have the second goal. This paper discusses test planning, sources for simulating loads, modeling, and instrumentation. The main source described involves controlled venting of explosive gases. The source avoids generation of undesirable shock waves and facilitates calibration because the reaction rate of the explosive is independent of the response. It is indicated that the test program requiring the least time and cost involves a mixture of three types of models: small simple models, small complex models, and large complex models. Instrumentation is discussed that is required for validation of loading, response measurements for comparison with calculations, and response measurements on critical members where predictions are not possible.

10452 Experimental study on dynamic response of reactor vessel to an HCDA. Ando, Y.; Kondo, S. (Tokyo Univ. (Japan). Faculty of Engineering); Yoshizawa, H. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan). Research and Development Center); Sasanuma, K. (Advanced Reactor Engineering Department, Atomic Power Division, Toshiba, Minatoku, Tokyo, Japan); Kawaguchi, O.;

Mochio, T. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). *Nucl. Eng. Des.;* **42**: No. 1, 105-113(Jun 1977).

From International seminar on Containment of Fast Breeder Reactors; San Francisco, USA (22 - 23 Aug 1977).

This paper presents a discussion on the model experiments results for reactor structure dynamic response on FBR hypothetical core disruptive accident (HCDA) and the results of analysis using the dynamic response analysis code under experimental conditions. The purpose of this study is to clarify experimentally the dynamic response by use of scale models, as well as to attempt to confirm and improve the dynamic response analysis code on the basis of experimental data. The experimental results have clarified the inner barrel effects on reactor vessel deformation and its behavior due to a impact load. On the other hand, dynamic analysis was made of the 1/7.5 scale complex model by a dynamic response analysis code 'PISCES-2DL', using the explosive combustion characteristics as inputs. Obtained values were compared with experimental values. Results showed that this method was fairly capable of evaluating radial deformation behavior in lower cylindrical parts of the vessel.

10453 Core debris behaviour and interactions with concrete. Baker, L. Jr. (Argonne National Lab., Ill. (USA)). *Nucl. Eng. Des.;* **42**: No. 1, 137-150(Jun 1977).

From International seminar on Containment of Fast Breeder Reactors; San Francisco, USA (22 - 23 Aug 1977).

The behavior of LMFBR core debris following a hypothetical core-disruptive accident (HCDA) depends upon a wide range of physical and chemical phenomena. Current understanding of the key phenomena are summarized for core-debris behavior within the reactor vessel, within the reactor cavity, and within the concrete base mat below the reactor cavity. In-vessel behavior was the principal consideration of post-accident heat removal for the FFTF reactor. Several concepts of engineered core-retention systems within the reactor cavity have been considered for other reactors, including the cooled crucible concept, the sacrificial barrier concept, the stable barrier concept, and the catch tray concept. Behavior within the concrete base mat is an important part of a general concept of inherent core retention which depends upon an understanding of the complex interactions of core debris with concrete.

10454 Methods and programs for analysis of fluid-structure systems. Belytschko, T. (Illinois Univ., Chicago (USA)). *Nucl. Eng. Des.;* **42**: No. 1, 41-52(Jun 1977).

From International seminar on Containment of Fast Breeder Reactors; San Francisco, USA (22 - 23 Aug 1977).

37 refs.

Computational algorithms for the analysis of fluid and structural dynamics are reviewed, with particular emphasis on methods that are employed or of potential benefit in reactor safety analysis, where coupled fluid-structure analyses are of interest. The fluid dynamics algorithms are classified according to time integration methods, mesh descriptions, and compressible/incompressible flow, while the structural dynamics algorithms are summarized from the viewpoints of time integration and the types of nonlinearities which can be treated. Alternative means of coupling these various fluid and structures algorithms are axamined. Finally the principal features of some existing programs are summarized.

10455 Application of containment codes to LMFBRs in the United States. Chang, Y.W. (Argonne National Lab., Ill. (USA)). *Nucl. Eng. Des.;* **42**: No. 1, 53-67(Jun 1977).

From International seminar on Containment of Fast Breeder Reactors; San Francisco, USA (22 - 23 Aug 1977).

This paper describes the application of containment codes to predict the response of the fast reactor containment and the primary piping loops to HCDAs. Five sample problems are given to illustrate their applications. The first problem deals with the response of the primary containment to an HCDA. The second problem deals with the coolant flow in the reactor lower plenum. The third problem concerns sodium spillage and slug impact. The fourth problem deals with the response of a piping loop. The fifth problem analyzes the response of a reactor head closure. Application of codes in parametric studies and comparison of code predictions with experiments are also discussed.

10456 Nuclear accident simulation in a 1/6 scale model of the SNR-300 fast breeder reactor. Egleme, M.; Fabry, J.P.; Lamotte, H. (Societe Belge pour l'Industrie Nucleaire, Brussels). *Nucl. Eng. Des.;* **42**: No. 1, 115-122(Jun 1977).

From International seminar on Containment of Fast Breeder Reactors; San Francisco, USA (22 - 23 Aug 1977).

In the frame of the licensing of the SNR-300 fast breeder reactor an HCDA has been investigated both by theoretical and experimental means. The latest phase of this programme was the simulation of a HCDA in a very well instrumented 1/6 scale model of the SNR-300 vessel. The Bethe-Tait accident was simulated by a slow burning charge. In order to check the reliability of the theoretical means allowing for an evaluation of these accidents, the German authorities wanted to receive, before the shot, a theoretical precalculation report showing the main permanent deformations and responses of the pressure and strain gauges versus time. This paper compares and comments on the most meaningful results of this experiment with the SURBOUM-II precalculated estimations.

10457 Assessment of accident energetics in LMFBR core-disruptive accidents. Fauske, H.K. (Argonne National Lab., Ill. (USA)). *Nucl. Eng. Des.;* **42**: No. 1, 19-29(Jun 1977).

From International seminar on Containment of Fast Breeder Reactors; San Francisco, USA (22 - 23 Aug 1977).

An assessment of accident energetics in LMFBR core-disruptive accidents is given with emphasis on the generic issues of energetic recriticality and energetic fuel-coolant interaction events. Application of a few general behavior principles to the oxide-fueled system suggest that such events are highly unlikely following a postulated core meltdown event.

10458 Transient containment response and inherent retention capability. Gluekler, E.L.; Dayan, A.; Hayes, F.; Kline, C.T. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). *Nucl. Eng. Des.;* **42**: No. 1, 151-167(Jun 1977).

From International seminar on Containment of Fast Breeder Reactors; San Francisco, USA (22 - 23 Aug 1977).

For safety assessments of early sodium cooled fast breeder reactors, hypothetical events such as loss of flow or transient overpower sequences combined with the failure of the reactor protective systems have been evaluated. The intent of these evaluations was to demonstrate that even extremely unlikely combinations of failures which could lead to meltdown of a portion of the reactor core would not propagate into events harmful to the public. This paper investigates the consequences of a meltdown event. In general, reactor vessels and the primary sodium systems have an adequate inherent retention capability to retain dispersed or molten core debris and remove decay heat. For certain vessel designs, large core debris masses may penetrate through the vessel wall and drain into the reactor cell. Although significant uncertainties exist in the evaluations of debris retention and heat removal capabilities of the containment, there is indication that criteria for radiological limits can well be met. If the accident progression can be controlled in-vessel, consequences would be minimized.

10459 Application of a coupled Euler-Lagrange computer program to the structural response of an LMFBR. Hancock, S.L. (Physics International Co., San Leandro, Calif. (USA)). *Nucl. Eng. Des.;* **42**: No. 1, 69-74(Jun 1977).

From International seminar on Containment of Fast Breeder Reactors; San Francisco, USA (22 - 23 Aug 1977).

This paper discusses the application of PISCES 2DELK, a coupled Euler-Lagrange computer code, to the response of an LMFBR to a hypothetical core-disruptive accident. The coupled Euler-Lagrange method allows one to use an Euler finite difference mesh to compute fluid flow and a Lagrange mesh to compute structural response. The finite difference equations are discussed, and a sample calculation is presented in which the sodium gas bubble expands around a movable internal structure.

10460 Testing philosophy and simulation techniques. Holtbecker, H. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). *Nucl. Eng. Des.;* **42**: No. 1, 75-87(Jun 1977).

From International seminar on Containment of Fast Breeder Reactors; San Francisco, USA (22 - 23 Aug 1977).

This paper reviews past and present testing philosophies and simulation techniques in the field of structure loading and response studies. The main objective of experimental programmes in the past was to simulate a hypothetical energy release with explosives and to deduce the potential damage to a reactor from the measured damage to the model. This approach was continuously refined by improving the instrumentation of the models, by reproducing the structures as faithful as possible and by developing new explosive charges. This paper presents an analysis of the factors which are expected to have an influence on the validity of the results e.g. strain rate effects and the use of water instead of sodium. More recently the discussion of a whole series of accidents in the probabilistic accident analysis and the intention to compare different reactor designs has revealed the need to develop and validate computer codes. Consequently experimental programmes have been started in which the primary aim is not to test a specific reactor but to validate codes. This paper shows the principal aspects of this approach and discusses first results.

10461 Disassembly energy release for mechanical damage evaluation. Jackson, T.F.; Boudreau, J.E. (Los Alamos Scientific Lab., N.Mex. (USA)). *Nucl. Eng. Des.;* **42**: No. 1, 31-40(Jun 1977).

From International seminar on Containment of Fast Breeder Reactors; San Francisco, USA (22 - 23 Aug 1977).

Techniques available for determining the energy release from prompt critical excursions in fast reactors are discussed. This includes models used to develop the pressure source-terms needed to analyze the structural response of the system. Methods for characterizing the work-potential available from energetic excursions are

reviewed. Areas where advanced models would be most beneficial are also discussed.

10462 Overview of core disruptive accidents. Marchaterre, J.F. (Argonne National Lab., Ill. (USA)). *Nucl. Eng. Des.;* **42**: No. 1, 11-17(Jun 1977).

From International seminar on Containment of Fast Breeder Reactors; San Francisco, USA (22 - 23 Aug 1977).

An overview of the analysis of core-disruptive accidents is given. These analyses are for the purpose of understanding and predicting fast reactor behavior in severe low probability accidents from initiating event to complete core disruption, the effects of the accident on reactor structures and the resulting radiological consequences are described.

10463 Experiments on sodium fires and their aerosols. Morewitz, H.A.; Johnson, R.P.; Nelson, C.T. (Atomics International Division, Rockwell International, Canoga Park, California, USA). *Nucl. Eng. Des.;* **42**: No. 1, 123-135(Jun 1977).

From International seminar on Containment of Fast Breeder Reactors; San Francisco, USA (22 - 23 Aug 1977).

A number of new sodium fire and aerosol experiments were undertaken to provide data for LMFBR safety analyses: (1) Experiments on the burning of single drops of liquid sodium falling in air have been performed to aid in model development for sodium spray fire codes. (2) The leakage of sodium oxide aerosols through a straight smooth capillary tube, representative of the maximum size of a hypothetical gas leak in the wall of the secondary containment of an LMFBR, has been studied. Even in those cases in which the capillary did not plug, <11% of the entering mass was of a respirable size as it emerged from the capillary. In addition, there were a number of conditions under which the capillary plugged. (3) Experiments on the behavior of high temperature, high concentration aerosols have shown a rapid depletion of the aerosol concentration in the first 6 sec following injection of approximately 800 g/m^3 aerosols at approximately 1000°C into a closed vessel. This depletion has been correlated with the early formation of 100 to 200 μm agglomerates which fall out promptly.

10464 Response of liquid metal fast breeder reactor containment to a hypothetical core meltdown accident. Peak, R.D.; Simpson, D.E.; Stepnewski, D.D. (Hanford Engineering Development Lab., Richland, Wash. (USA)). *Nucl. Eng. Des.;* **42**: No. 1, 169-180(Jun 1977).

From International seminar on Containment of Fast Breeder Reactors; San Francisco, USA (22 - 23 Aug 1977).

This paper presents an analysis of the response of the containment building of a 2500-MWt liquid metal fast breeder reactor to a hypothetical reactor core meltdown. Although not mechanistically justifiable, this type of event is chosen for analysis as a basis for risk assessments. Containment space atmosphere compositions, temperatures, pressures, and structural temperatures are calculated, based on decay energy release and chemical reactions associated with the incident. The CACECO containment analysis code, which was used to make the calculations, is described in detail. Results of the study show that by utilizing the passive heat absorption capability of structures normally present in containment design, reactor plant containment integrity can be maintained for more than a day, even for extreme hypothetical events.

10465 Safety requirements to be met by nuclear power plants. Pt. 14. Safety philosophy and safety policies. Franzen, L.F. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.). Gruppe Information). *Atomwirtsch., Atomtech.;* **22**: No. 6, ang p. 2, 4(Jun 1977). (In German).

Presented are reflections on the safety philosophy relevant for safety requirements, and on the safety policies resulting thereof as well as on the changes both philosophy and policies are subject to.

10466 Failure modes of alternative containment designs following postulated core meltdown. Chan, C.K.; Knee, H.E.; Okrent, D. (California Univ., Los Angeles (USA). Dept. of Energy and Kinetics). *Nucl. Eng. Des.;* **24**: No. 3, 399-410(May 1977).

The containment response to a postulated core meltdown accident in a PWR ice condenser containment, a BWR Mark III containment and a BWR non-inerted Mark I containment has been examined to see if the WASH-1400 containment failure mode judgement for the Surry large, dry containment and the Peach Bottom Mark I inerted-containment are likely to be appropriate for these alternative containment plant designs. For the PWR, the representative accident chosen for the analysis is a large cold leg break accompanied by a loss of all electric power while the BWR respresentative event chosen is a recirculation line break without adequate core cooling function. Two containment event paths are studied for each of these two cases, depending on whether or not containment vapor suppression function is assumed to be available. Both the core and the containment pressure and temperature response to the accident events are computed for the four time intervals which characterize (a) blowdown of the pipe break, (b) core melt, (c) vessel melt-through, and (d) containment foundation penetration. The calculations are based on a best esimate of the most probable sequence, but certain phenomena and events were followed down multiple tracks. It appears that the non-inerted Mark I containment is not so vulnerable to overpressurization from hydrogen burning as the Mark III; however, acceptable temperatures may be exceeded.

10467 Integrated safe shutdown heat removal system for light water reactors. Ebersole, J.C.; Okrent, D. (California Univ., Los Angeles (USA). Dept. of Energy and Kinetics). *Nucl. Eng. Des.;* **24**: No. 3, 421-435(May 1977).

A design concept is introduced for an integrated safe shutdown heat removal system (ISSS) for light water reactors that is independent of all components and systems outside the primary containment (other than the elements of the ISSS itself) and which includes an integral stored water supply. The principal purpose is to obtain a simple, reliable, and highly protected means for water makeup and steam release for basic post-scram cooling. The objective of the system is to provide safe shutdown cooling under virtually all emergency conditions which do not involve the loss of coolant caused by piping failures within the primary containment. Thus, the system is designed for the hazards of fire and sabotage as well as numerous other potential accidents, all of them considered as a set of events to be handled by the same system, rather than as discrete problems - each with its own, sometimes contradictory, solution.

10468 Safety of the fast reactor. Matthews, R.R. (Central Electricity Generating Board, London (UK). Nuclear Health and Safety Dept.). *Atom (London);* No. 247, 86-89(May 1977).

From Meeting at Imperial Coll. of Science and Technology; London, UK (15 Jan 1977).

Verbatim of an address by R.R. Matthews, Chief Nuclear Health and Safety Officer, UK Central Electricity Generating Board given on January 15th 1977. The object of this address was to give some opinions on the safety issues of fast reactors as seen from an operational point of view. An outline of the basic responsibilities for nuclear safety is first given, and it is emphasized that the Central Electricity Generating Board has a statutory responsibility for the safe operation of its nuclear plant. The Nuclear Installations Act places absolute responsibility on the operator for ensuring that injury to persons and damage to property do not occur, and the new Health and Safety at Work Act does likewise. In addition the Board has a Nuclear Health and Safety Department that has to ensure that adequate provision for safety is made in the design, construction, and operation of nuclear plant, and safety at operational stations is monitored continuously by inspectors. In addition the requirements of the Nuclear Installations Inspectorate, laid down in the site licence conditions, must be satisfied. All these requirements are here discussed in the light of application to commercial fast reactors. It is considered that the hazards to fast reactor operating personnel are small and little different from those of other types of reactor, and in some respects the fast reactor has advantages, particularly in regard to the use of a Na coolant. The possibility of various types of accident is considered. Radioactive effluent discharge is also considered. The fast reactor as an international problem is discussed, including security matters. The extensive experience gained in operation of the experimental and prototype fast reactors at Dounreay is emphasized.

10469 Analysis of EBR-II secondary sodium network for pressures pulses due to leaks of steam on water into sodium. Srinivas, S.; Chopra, P.S. (Argonne National Lab., Ill. (USA)). *Nucl. Eng. Des.;* **24**: No. 3, 313-325(May 1977).

A systematic procedure is presented for the safety analysis of the secondary sodium system of an LMFBR in the event of a leak of water or steam into sodium in an evaporator or a superheater. Using fracture mechanics, it is shown that the usual assumption of failure initiation by guillotine rupture of one or more water or steam tubes is unrealistic. A model is proposed for the gradual growth of leaks due to the phenomenon of wastage. The pressure rise in the system due to a sodium-water reaction is calculated solving one-dimensional hydrodynamic equations. By comparing results obtained for the proposed gradual growth model with those due to guillotine failure it is shown that the assumption of guillotine failure leads to a significant overestimation of pressures and stresses. Based upon the proposed leak progression model the stresses in the EBR-II secondary sodium system are shown to be within safe limits.

10470 Safety requirements to be met by nuclear power plants. Pt. 13. Subsequent safety requirements. Franzen, L.F. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.). Gruppe Information). *Atomwirtsch., Atomtech.;* **22**: No. 5, ang p. 2-3(May 1977). (In German).

The safety requirements which are made during the lifetime of a nuclear power plant at a later stage (so-called 'backfitting') are dealt with. These requirements can become necessary on account of new knowledge, and alterations in environment and dimensions (of a political- sociological kind).

10471 Radiation protection during the first refueling shutdown of unit A of Biblis nuclear power station. Meyer, F.; Schroeder, H. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G., Biblis (Germany, F.R.). Betriebsverwaltung). *Kerntechnik;* **19**: No. 3, 117-121(Mar 1977). (In English, German).

The organizational framework of radiation protection for the first detailed inspection, with fuel element change, of unit A of Biblis nuclear power station is described as well as the results, difficulties and pecularities of radiation protection monitoring. Observing the permissible limit values 1350 persons received 348 rem (film values) from 1st April to 31st August 1976.

10472 Annual colloquium 1976 of the Project Nuclear Safety of the GfK. Bayer, A.; Dalle Donne, M. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). *KFK Nachr.;* **9**: No. 1, 30-34(1977). (In German).

3 figs.

A brief summary is given of lectures which present a survey of project activities terminated and in progress.

10473 German reactor safety study. Birkhofer (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Garching/Muenchen (Germany, F.R.)). *Gut;* No. 22, 1-4(1977). (In German).

A brief report on the state of the activities concerning the reference plant Biblis-B is presented. Technical investigations concerning the plant (determination of events causing incidents, analysis of the possible course of an incident up to possible fission product release into the environment) are carried out by the GRS, risk analysis and determination of accident consequences (atmospheric diffusion of fission products, resulting damage) by the GfK and the GSF.

10474 Assessment of the stresses from the load earthquake. Hasse, E. (Technische Hochschule Darmstadt (Germany, F.R.). Inst. fuer Massivbau). *Bautechnik;* **54**: No. 1, 7-17(1977). (In German).

14 figs.; 5 tabs.; 17 refs.

Without accounting for the vibrating properties, earthquake analysis cannot yield satisfactory results. Calculation with a ground acceleration taken constant over the total height of the building lies on the safe side for a yielding structure but on the unsafe side for a rigid structure. The recommendations of DIN 4149 are only valid for rigid structures. The actual approximation method according for the preliminary guidelines, based on a number of limiting assumptions, within its range of validity $T <= 1.0$ s yields sufficiently reliable results. With the aid of this paper, the following additions to the preliminary guidelines are possible: 1) fully dynamic vibration analysis; 2) non-uniform distribution of masses and rigidities; 3) consideration of torsional vibrations (as well as rotational vibrations and shear deformations). Computation according to the EFAS method, the schematic flow diagram of which is presented, is recommended only for buildings with a large safety requirement and a site in seismically active areas. For the vast majority of buildings in German seismic areas, seismic stresses should be continued to be evaluated by simple approximations. In a country like the Federal Republic with relatively small seismic activity, large computational effort may very easily stand in a wrong relationship to the importance of the load case earthquake - especially if the uncertain input data are considered.

10475 Modification in installation of the reactors of Kansai Electric Power's Takahama Power Station (modifications of Unit 1 and 2 reactor plants). *Genshiryoku Iinkai Geppo;* **21**: No. 7, 7-9(Oct 1976). (In Japanese).

Results of the study by the Committee for Examination of Reactor Safety, reported to the AEC of Japan, are presented, concerning safety of the modifications of Takahama Power Station, The Kansai Electric Power Co., Inc. Safety has been confirmed thereof. The modifications covered are the following: site of Unit 2 in dimensions, enrichment of the uranium fuel in Unit 1 and 2 in decrease, storage facility of spent fuel in Unit 2 in capacity increase, boron concentration in Unit 2 in adjustment, and usage of a burnable poison in Unit 2.

10476 Modification in installation of the reactor of Kansai Electric Power's Mihama Power Station (modifications of Unit 3 reactor plant). *Genshiryoku Iinkai Geppo;* **21**: No. 7, 9-10(Oct 1976). (In Japanese).

Results of the study by the Committee for Examination of Reactor Safety, reported to the AEC of Japan, are presented, concerning safety of the modifications of Mihama Power Station, The Kansai Electric Power Co., Ltd. Safety has been confirmed thereof. The modifications covered are the following: enrichment of the uranium fuel in decrease, storage facility of spent fuel in capacity increase, boron concentration in adjustment, and usage of a burnable poison.

10477 Modification in installation of the reactor of Power Reactor and Nuclear Fuel Development's Tsuruga Works (modifications of the prototype advanced thermal reactor plant). *Genshiryoku Iinkai Geppo;* **21**: No. 7, 11-12(Oct 1976). (In Japanese).

Results of the study by the Committee for Examination of Reactor Safety, reported to the AEC of Japan, are presented, concerning safety of the modifications of Tsuruga Works, Power Reactor and Nuclear Fuel Development Corporation. Safety has been confirmed thereof. The modifications covered are the following: fuel assemblies in replacement with monitoring assemblies, storage facility of new fuel in capacity increase, and storage facility of solid wastes in reinforced concrete.

10478 SOWACS-3: a code for analyzing the system effects of large-leak sodium-water reactions in steam generators for LMFBR's. Maekawa, I.; Shindo, Y. (Kawasaki Heavy Industries Ltd., Kobe (Japan)). *FAPIG (Tokyo);* No. 82, 31-42(Aug 1976). (In Japanese).

In liquid metal-cooled fast breeder reactors, since heat exchange is performed between sodium and water or steam, sodium-water reaction occurs if sodium leak arises, and it may give great influence on the secondary cooling system. Large leak sodium-water reaction shows the complex phenomena related to hydrodynamics, thermodynamics, and structural dynamics, and more complicate behavior is shown because the transient phenomena of the release system are superposed. SOWACS-3 (SOdium WAter reaction in Compressible Sodium-3) is a code to analyze the instant complex phenomena in the large leak of steam generators, and the effect of sodium-water reaction over secondary coolant pipes, intermediate heat exchanger, steam generator and release system is analyzed. SOWACS-3 analyzes the one dimensional model of unsteady compressible fluid in accordance with flow equations and by the characteristics curve method. The report describes the fundamental formulae, numerical calculation procedures and the construction of computing codes.

10479 AEC sets five year nuclear safety research program. *At. Jpn.;* **20**: No. 6, 6-16(Jun 1976).

The research by the government for the establishment of means of judging the adequacy of safety measures incorporated in nuclear facilities, including setting safety standards and collecting documents of general criteria, and the research by the industry on safety measures and the promotion of safety-related technique are stated in the five year program for 1976-80 reported by subcommittees, Atomic Energy Commission (AEC). Four considerations on the research items incorporated in the program are 1) technical programs relating to the safety of nuclear facilities and the necessary criteria, 2) priority of the relevant items decided according to their impact on circumstances, urgency, the defence-indepth concept and so on, 3) consideration of all relevant data and documents collected, and research subjects necessary to quantify safety measurement, and 4) consideration of technological actualization, the capability of each research body, the budget and the time schedule. In addition, seven major themes decided on the basis of these points are 1) reactivity-initiated accident, 2) LOCA, 3) fuel behavior, 4) structural safety, 5) radioactive release, 6) statistical method of safety evaluation, and 7) seismic characteristics. The committee has deliberated the appropriate division of researches between the government and the industry. A set of tables showing the nuclear safety research plan for 1976-80 are attached.

10480 Probability method and application possibilities to the study of nuclear sites. Candes, P. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Surete Nucleaire). *Rev. Gen. Nucl.;* No. 5, 401-405(1976). (In French).

The applications of the probabilistic method are described at the level of the different aspects characterizing a nuclear site, i.e. phenomena external to the plant, or natural or human origin, capable of giving rise to damage of more or less severity, causing radioactivity dispersion, phenomena of internal origin, leading in particular to wonder about population distribution about the site according to the potential danger of the plant considered and the meteorological conditions prevailing on the site. As conclusion, it is noted that the application of safety criteria applicable to nuclear sites is subjected to numerous difficulties, both physical, technical and administrative, but that the probabilistic way has determined sensible progress in this field and allowed to expect new significant results.

10481 Application of probability methods with a view to improving the quality of equipment. Carnino, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Surete Nucleaire); Gachot, B. (Electricite de France, 92 - Courbevoie. Service Etudes et Projets Thermiques et Nucleaires); Greppo, J.F. (Electricite de France, 75 - Paris. Service de la Production Thermique); Guitton, J. (Electricite de France, 75 - Paris. Direction des Etudes et Recherches). *Rev. Gen. Nucl.;* No. 4, 313-320(1976). (In French).

After stating that reliability and availability could be considered as parameters allowing the quality of equipment to be estimated, the chief aspects of the use of probability methods in the field of quality is described. These methods are mainly applied at the design,

operation and maintenance level of the equipment, as well as at the compilation stage of the corresponding data.

10482 Application of probabilistic methods in the field of nuclear safety. Carnino, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette. (France). Dept. de Surete Nucleaire). *Rev. Gen. Nucl.;* No. 5, 406-419(1976). (In French).

Beyond the determination of the risks of accident to the reactors (Rasmussen Report), the probabilistic methods have other fields of application insofar as nuclear safety is concerned. These different fields of application are studied, i.e.: analysis of the accidents and of system performance, research for solutions to obtain an improved reliability, determination of the operating rules of the plants and drawing up of the regulations. In order to illustrate the work tending to improve the reliability, the studies concerning the design of the emergency shutdown system of the Super-Phenix are presented as an example.

10483 Reliability studies at Framatome - Examples of applications. Coudert, C. (Societe Franco-Americaine de Constructions Atomiques (FRAMATOME), 92 - Courbevoie (France)). *Rev. Gen. Nucl.;* No. 5, 437-443(1976). (In French).

The studies that have been developed at Framatome in the line of the reliability analysis of systems and in the line of the probability analysis of accidents, taking for examples the loss of primary coolant and the loss of external electric power supplies are described. The probability studies about the different situations related to the primary circuit design, in particular the over-pressure problems are presented.

10484 Application of the probabilistic method at the E.D.F. Gachot, B. (Electricite de France, 75 - Paris). *Rev. Gen. Nucl.;* No. 5, 420-431(1976). (In French).

Having first evoked the problems arising from the definition of a so-called 'acceptable risk', the probabilistic study programme on safety carried out at the E.D.F. is described. The different aspects of the probabilistic estimation of a hazard are presented as well as the different steps i.e. collecting the information, carrying out a quantitative and qualitative analysis, which characterize the probabilistic study of safety problems. The problem of data determination is considered on reliability of the equipment, noting as a conclusion, that in spite of the lack of accuracy of the present data, the probabilistic methods already appear as a highly valuable tool favouring an homogenous and coherent approach of nuclear plant safety.

10485 Quality and safety of nuclear plants: the part played by the administrative authorities. Queniart, D. (Ministere de l'Industrie et de la Recherche, 75 - Paris (France). Service Central de Surete des Installations Nucleaires). *Rev. Gen. Nucl.;* No. 4, 302-307(1976). (In French).

After specifying the notions of 'safety' and 'quality', the terms and conditions governing the intervention of the public authorities in the matter of safety of nuclear plants are described: individual permits, the establishing and application of technical rules of a general character, surveillance of the plants. The criteria and regulations guiding the evaluation of safety and quality and, in conclusion, insisting on the necessity for permanent discussions among the various organizations concerned are presented.

10486 Nuclear safety and probabilistic methods. Tanguy, P. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Surete Nucleaire). *Rev. Gen. Nucl.;* No. 5, 392-400(1976). (In French).

Having first recalled the principles of conventional methodology concerning nuclear safety, the probabilistic approach is defined, as it has been elaborated by Dr Farmer. The basic rules which determined the elaboration of the Rasmussen report as well as the main conclusions of this report are commented. Definition of the evolution prospects - possible and advisable - of the probabilistic method as concerns nuclear safety are defined.

10487 Effect of failures under operating conditions on the characteristics of a power plant with a dissociating coolant. Gimmel'shtein, Y.E.; Greben'kov, Z.A.; Zatsepin, O.I.; Serebryanaya, V.V. (AN Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 4, 32-36(1976). (In Russian).

The small-deviation method to linearize the initial set of equations and an application of the linearized equations to calculate sufficiently small changes in the power plant regime are considered. By using this method it is possible to draw up to a table of induction coefficients which shows a change of some parameters affecting the rest parameters of the plant. The parameters which can change due to different damages causing no emergencies and requiring no shutdown of the plant for maintenance are assumed to be independent. The allowance of the effect of these damages on the main parameters of the plant and the coolant is presented in tables of induction coeffisients, which make it possible to evaluate the quantitative effect of a change in these parameters on others. The induction coefficients may be also used to forecast damages of the plant. According to the results of the determined parameters when operating the plant, using these table data, it is possible to detect the most probable damage having caused that or the other change in parameters in the process of operating a power plant.

10488 Technique for investigating emergency processes in a reactor with a dissociating coolant. Sharovarov, G.A.; Tashchilova, A.M.; Zenich, T.S. (AN Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 4, 24-31(1976). (In Russian).

The problem of emergency processes dynamics in a reactor with the dissociating coolant are considered. A mathematical model for describing dynamics of a reactor channel is presented and a method of solving a set of equations using the 'Minsk-22'- computer is described. The results of calculations are given for the case of an emergency change in neutron power due to a withdrawal of control rods and in the case of sealing loss in the circuit behind turbines. It is shown that comparatively small changes in fuel temperature are observed in the nuclear plant and there is enough time for the reactor shutdown and switching on the emergency system.

10489 Connection between cyclic thermal shocks and reliable operation of boiler steels. Ginsztler, J. (Budapesti Muszaki Egyetem (Hungary)). *Engei Gakkai Zasshi;* **29**: No. 8, 364-370(1976). (In Hungarian).

In the pressure vessels of nuclear power plants macroscopic cracks can occur owing to the combined effect of creep and fatigue. According to the experiments the specific fracture energy in specimens after low-cycle thermal fatigue may decrease to a crytical value. The scanning and transmission electron microscopy of the material revealed that during fatigue loading cracks initiate along the ferrite-pearlite grain boundaries. The crack initiation is preceded by micro voids and wedge-type microcracks on the grain boundary. Also plastic deformation and an increased dislocation density can be met within the grains. A stress peak around the carbide particles hinders the dislocation in movement, thus promotes the woid formation. During heat cycles the smaller carbide particles dissolve, the size of greater carbide particles increases.

10490 (EURFNR—1444) **Fast Breeder Project. Fourth quarterly report, 1976.** Hueper, R. (comp.). (Kernforschungszentrum Karlsruhe (Germany, F.R.)). 1976. Translation of KFK—1276/4. 153p. Dep. NTIS, PC A08/MF A01.

Work performed under United States—Euratom Fast Reactor Exchange Program.

Progress is summarized in the areas of fuel rod development, materials studies, corrosion experiments, reactor kinetics, reactor safety, and sodium technology. (DG)

10491 Apparatus for controlling a core cooling system in case of emergency. Watanabe, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-136096/A/. 19 May 1975. 4p. (In Japanese).

An apparatus is disclosed whose purpose is to securely perform low level control of main cooling system, particularly, vapor generator at the time of minor trouble such as power failure in a fast breeder plant and to securely and safely perform core cooling in combination with auxiliary cooling system. When power failure occurs, a sequence control gives instructions to start the auxiliary system secondary pump and blower and sodium temperature at outlet of air cooler is controlled constant by a damper control. Primary and secondary pumps in the main cooling system are tripped by respective controls and shifting into pony motor drive. By a pressure control, a superheater separating valve is closed and a flush valve is opened so that a vapor generator is formed into individual operation of evaporator and is switched to a low level control system. The water pump is shifted to motor drive and a water supply controller keeps a temperature on low temperature side of the main cooling system constant.

10492 Emergency pressure reduction means for a nuclear power plant. Ueda, T.; Tsuge, A. (to Mitsubishi Heavy Industries Ltd., Tokyo (Japan)). Japanese Patent 1976-124790/A/. 22 Apr 1975. 4p. (In Japanese).

The objectof the invention is to prevent environmental contamination due to a radioactive contaminant vapor by an arrangement in which a turbine drive steam supply duct of a steam generator is connected through safety valves to a cooling distillation section so that at the time of an accident the generated steam can be subjected to pressure reduction through condensation in a cooling liquid pool and thus prevented from leaking to the outside. Structure: When rupture of a fine heat conduction duct within a steam generator takes place, causing a high pressure, high temperature cooling water in the primary cooling system to jet into the secondary cooling system so that the tolerance value is ultimately exceeded by the quantity of radioactive substance discharged into the secondary cooling system, a steam cut-off valve and a water supply cut-off valve are closed to isolate the steam generator. Then the safety

valves are successively opened in accordance with the increase in the inner pressure on the secondary cooling system side of the steam generator, whereby high pressure steam is jetted through a steam jet duct into liquid within a cooling liquid pool and condensed there.

ENERGY STORAGE

FLYWHEELS

REFER ALSO TO CITATION(S) 10661

10493 (Y/DA—7291) **Prestressed thick flywheel rims.** Knight, C.E. Jr.; Pollard, R.E. (Oak Ridge Y-12 Plant, Tenn. (USA)). 1977. Contract W-7405-ENG-26. 10p. (CONF-771053—4). Dep. NTIS, PC A02/MF A01.

From Flywheel technology symposium; San Francisco, California, USA (5 Oct 1977).

A homogeneous fiber composite flywheel rim has a radial tensile stress distribution when spinning about its axis of cylindrical symmetry. A circ-wound rim is ideally suited to support the very high hoop stresses, but it can only support very low radial tensile stresses. This limits the allowable rim inside-to-outside radius ratio so that the energy stored per unit volume is low. It would be desirable to have relatively thicker rims with no radial tensile stresses at the ultimate design speed for hoop stress failure. The methods for calculating the prestress produced by a given schedule of winding tensions are given. The significant parameters to be controlled in the fabrication process are presented. Some tension schedules for balancing the radial rotational stress in rims of a specific size and material are also presented. Experimental development of prestress conditions in small scale test ring demonstrates the capability to achieve prestress levels that can effectively eliminate radial tensile stress in the composite thick rim. Successful experimental development led to the fabrication of a full scale prestressed flywheel rim and utilization of that rim in the Oak Ridge Y-12 Plant FY 1977 flywheel test package.

THERMAL

REFER ALSO TO CITATION(S) 9943, 9985

10494 **Heat storage system.** Morawetz, E.; Glas, L.O. US Patent 4,044,949. 30 Aug 1977. Filed date 26 Feb 1976. 10p.

An automatic heat storage system is described that is comprised of two cooperating sources of heat, two heat storage vessels, and a heat emitting system, the heat being transferred by a heating medium common for the entire system. Preferably, one of the sources of heat is a solar energy collector system.

10495 **Thermal energy storage systems employing metal hydrides.** Libowitz, G.G. (to Allied Chemical Corp.). US Patent 4,040,410. 9 Aug 1977. Filed date 14 Jun 1976. 8p.

Thermal energy storage systems employing metal hydrides are useful for storing thermal energy produced, for example, by solar radiation. The metal hydrides, examples of which include FeTiH and the VH—VH_2 reaction system, evidence ease of reversibility of the metal-hydrogen reaction and have relatively high heats of formation. An additional advantage of the metal hydrides over other thermal storage materials is that the metal hydrides permit a greater degree of control to be exercised over the rate of heat evolution when needed.

BATTERIES

REFER ALSO TO CITATION(S) 10745

DESIGN AND DEVELOPMENT

10496 **Lithium—aluminum/metal sulfide batteries.** Steunenberg, R.K. New York; American Inst. of Aeronautics and Astronautics (1977). 10p.

From AIAA conference on the future of aerospace power systems; St. Louis, MO, USA (1 Mar 1977).

Rechargeable lithium—aluminum/metal sulfide batteries are being developed for electric vehicle propulsion and for stationary energy storage applications such as load leveling in electric utility systems. Although these two applications have different requirements, batteries of this type show promise of meeting the performance, lifetime and cost goals for both. Cells are being produced and tested both in house and by industrial subcontractors. Conceptual battery designs have been developed, and two- and three-cell batteries have been operated successfully. Although the development work has been aimed primarily at these two large-scale applications, batteries of this type may find near-term use in more specialized applications that require high specific energy and power, but where the cost restrictions are less stringent. 7 figures, 11 tables.

10497 **Lead acid cells and batteries.** Peters, K.; Fewster, S.; Wilson, F.; Kearney, K.D.N. (to Chloride Group Ltd.). US Patent 4,053,695. 11 Oct 1977. Priority date 31 Oct 1974, United Kingdom of Great Britain and Northern Ireland (UK). 20p.

A sealed lead—acid cell is disclosed which has electrodes comprising metallic supports which minimize the evolution of hydrogen and resist deformation under their own weight, and which are separated by at least one layer of separator material. The capacity of the negative electrodes is arranged to be at least as great as the capacity of the positive electrodes. The thickness of the electrodes is less than 3 mm; the thickness of the separator is in the range of 10 to 200 percent of the thickness of the electrodes; and the volume, E, of electrolyte in the cell in relation to the sum of the pore volume of the separators, X, and the pore volume of the positive and negative active materials, Y, is not greater than $2X + Y$. 12 figures.

10498 **Porous light weight battery filler.** Ciliberti, F.L. Jr. (to P.R. Mallory and Co., Inc.). US Patent 4,053,691. 11 Oct 1977. Filed date 1 Oct 1976. 8p.

A method of encasing electrochemical cells in a porous structure of pellets adhered to one another enabling individual cell venting and a battery utilizing the porous structure are described. 3 figures, 2 tables.

10499 **Electrochemical cell with a graphite intercalation compound cathode.** Shropshire, J.A.; Newman, G.H. (to Exxon Research and Engineering Co.). US Patent 4,052,539. 4 Oct 1977. Filed date 17 Jan 1977. 4p.

A battery is disclosed having a nonaqueous electrolyte, an alkali metal anode, and a cathode comprising a compound of graphite formed by reacting graphite with ClF_3 and a Lewis acid fluoride of an element selected from B, Si, Ge, Sn, Pb, P, As, Sb, Bi, Ti, Zr, Hf, V, Nb, and Ta. 1 table.

10500 **Electrochemical battery.** Lindstrom, O.B. US Patent 4,049,878. 20 Sep 1977. Priority date 12 May 1975, Sweden. 6p.

An electrochemical battery including several modules interconnected electrically in series is described. Each module comprises several cells connected electrically in parallel. Each cell includes positive and negative electrodes. An electrolyte supply channel is individually connected to electrolyte spaces in each cell to supply electroyte to it. The cells of each module are fluidly interconnected at their lower ends in parallel by means of cross-channels. Optionally, these cells may also be fluidly interconnected at their upper ends in parallel by additional cross-channels. 2 figures.

10501 **Self-generating halogen liquification in a secondary battery.** Hart, T.G. (to Energy Development Associates). US Patent 4,049,880. 20 Sep 1977. Filed date 11 Jun 1976. 8p.

A system which permits self-generating halogen liquefaction in a rechargeable battery and apparatus for use in that system are disclosed. The system includes the use of separate electrolyte flows for the metal electrode and halogen electrode, the electrolyte being separated by a permselective membrane, and a halogen gas accumulator which communicates with the halogen gas being generated at the halogen electrode. 7 figures.

10502 **Gas- and liquid-tight storage battery.** Schenk, G.; Haake, H. (to Varta Batterie AG). US Patent 4,049,883. 20 Sep 1977. Priority date 24 Sep 1975, German, Federal Republic of (F.R. Germany). 6p.

A storage battery sealed gas-tightly and liquid-tightly is described in which an electrode set with a pole lead is inserted into a battery casing fully open at one end and closed at the other end except for a central opening through which the pole lead extends. Insulation prevents electrical contact between pole lead and casing. A bottom disk is welded on the full opening of the casing to make it electrolyte-tight and gas-tight. Electrolyte is introduced through the central opening, and the opening is then sealed. In the preferred system, the pole is a hollow terminal post connected to a contact disk attached to electrodes of one polarity of the electrode winding. The electrodes of other polarity are connected to a bottom disk which is welded on the full opening. 1 figure.

10503 **Sodium—sulfur electric cell.** Desplanches, G.; Lazennec, Y.; Wicker, A. (to Compagnie Generale d'Electricite S.A.). US Patent 4,049,884. 20 Sep 1977. Priority date 24 Apr 1975, France. 6p.

The invention relates to a new structure for a sodium—sulfur cell. Such a cell comprises a cathode tank containing sulfur, an electrolyte tube closed at its lower end containing sodium and immersed in sulfur, a sodium anode tank, and a ceramic support holding the tank and the tube. The cathode tank is fitted with graphite felt washers to ensure cathode collection of the current. The outside face of the electrolyte tube, except for the lower end, is

lined with a porous insulating coating. A graphite felt part is inserted between the lower end of the electrolyte tube and the bottom of the cathode tank. The invention is implemented in sodium—sulfur cell batteries for electric vehicles. 1 figure.

10504 Rechargeable aqueous metal-halogen cell. Will, F.G. (to General Elecrtric Co.). US Patent 4,049,886. 20 Sep 1977. Filed date 13 Dec 1976. 6p.

A rechargeable aqueous metal—halogen cell is described which includes a casing; a pair of spaced-apart porous electrode substrates in the casing; a microporous separator between the electrode substrates defining a positive and a negative electrode compartment; an aqueous electrolytic solution containing a zinc salt selected from the class consisting of zinc bromide, zinc iodide, and mixtures thereof in both compartments; and an organic halogen complexing additive of nitrobenzene in the electrolytic solution of at least the positive compartment. 2 figures.

10505 Method and apparatus for interconnecting stacked electrodes of batteries. Rothbauer, H. (to Maxs AG). US Patent 4,048,397. 13 Sep 1977. Filed date 24 Nov 1975. 4p.

Electrodes utilized in various types of batteries are interconnected by means of a pair of conductive bands insulated from each other and bent into a zig-zag formation. Each conductive band overlays an electrode of one polarity, and thus performs the function of separator as well as terminal conductor. Upon compression of the stacked electrodes into a housing, a compact battery is produced. 7 figures.

10506 Multicell electric batteries. White, C.A.J. (to Chloride Group Ltd.). US Patent 4,048,400. 13 Sep 1977. Priority date 6 May 1975, United Kingdom of Great Britain and Northern Ireland (UK). 4p.

A multicell electric battery has an intercell partition, the faces of which comprise two parallel conducting sheets connected together, as by spot welding, by means of one or more symmetrically positioned dimples, which constitute intercell connectors. Each conducting sheet is electrically connected to the adjacent electrode plate, either directly or indirectly by means of a compressible conducting cushion which contacts the sheet and either the adjacent plate or a further sheet which is electrically connected to the adjacent plate. The invention also includes a method of assembling a multicell electric battery which includes sliding the plates of each cell as a unit incorporating contacts into a battery casing also incorporation contacts--the intercell and/or terminal connections being effected by sliding engagement between the contacts of the plate unit and those of the casing. 7 figures.

10507 Electrophysichemical device. Bro, P. (to P.R. Mallory and Co., Inc.). US Patent 4,048,404. 13 Sep 1977. Filed date 8 Mar 1976. 4p.

A fast chargeable and rechargeable energy storage system to serve as an electrical power supply, that can be fully charged or recharged in less than a minute, consists of an electric cell with two polar electrodes, as to anode and cathode, with an electrolyte between them. The anode and the electrolyte are essentially nongassing. The operation during charge is a coupling of a chemical process with an electrochemical process. Circuit voltage is open 0.75 volt and energy storage capacity about 37.5 milliwatt hours in presently available units of small size. 2 figures, 2 tables.

10508 Na/S cell reactant container with metal aluminide coating. Chatterji, D.; Dubin, R.R. (to Electric Power Research Inst.). US Patent 4,048,390. 13 Sep 1977. Filed date 20 Dec 1976. 4p.

Electrically conducting components of sodium/sulfur batteries subject to the corrosive attack of the cell reactants are protected by aluminiding to provide a conductive, protective coating of a metal aluminide. The protective coating finds particular application in the metal conducting container forming the sulfur compartment, where the metal aluminide reacts with the sulfur and sodium polysulfide to form a protective, doped, aluminum sulfide coating, which is conductive due to the presence of the metal from the container.

10509 Electric cells. Evans, L.S.; Bones, R.J.; Harbar, J.R. (to Secretary of State for Industry in Her Britannic Majesty's Government of the United Kingdom of Great Britain and Northern Ireland). US Patent 4,044,191. 23 Aug 1977. Priority date 24 Dec 1974, United Kingdom of Great Britain and Northern Ireland (UK). 6p.

In an electric cell having a solid electrolyte which bounds on one side a compartment for liquid anode and on its opposite side a compartment for liquid cathode, the liquid anode compartment is made of very limited capacity. The bulk of the liquid anode required by the cell is held in a reservoir and fed to the liquid anode compartment by a capillary duct to provide a restricted feed which limits the flow of liquid anode between reservoir and compartment. The reservoir may be disposed within the cell, or outside the cell, and may supply liquid anode to several cells. 6 figures.

10510 Electric batteries. Evans, L.S.; Harbar, J.R. (to Secretary of State for Industry in Her Britannic Majesty's Government of the United Kingdom of Great Britain and Northern Ireland). US Patent 4,044,194. 23 Aug 1977. Filed date 30 Jun 1975. 8p.

The invention comprises an electric battery of the kind for use with a liquid anode, a liquid cathode, and a solid electrolyte, and having a number of cells nested one within the other such that adjacent cells share and are separated by a common electrode. The common electrode may provide a series connection or a parallel connection between adjacent cells. 4 figures.

10511 Silver peroxide—zinc battery. Nishimura, H.; Nomura, Y. (to Citizen Watch Co., Ltd.). US Patent 4,041,219. 9 Aug 1977. Priority date 12 Dec 1975, Japan. 6p.

A silver peroxide—zinc battery has a positive active material composed of silver peroxide, a negative active material composed of zinc, and an electrolyte comprising an aqueous alkaline hydroxide solution. An oxide of manganese is added to the silver peroxide. 7 figures, 2 tables.

10512 Sodium—sulfur battery, more particularly for electrical drive. Desplanches, G.; Lazennec, Y.; Wicker, A. (to Compagnie Generale d'Electricite S.A.). US Patent 4,041,216. 9 Aug 1977. Priority date 17 Mar 1975, France. 6p.

The invention relates to a sodium—sulfur battery for electrical drive. It is formed by elements, each comprising a cathode tank containing sulfur, a solid electrolyte tube closed at its lower end, containing sodium and arranged in the cathode tank, a ceramic insulating support for keeping the electrolyte tube in the cathode tank, and an anode tank containing a supply of sodium. The battery comprises m groups of n nodules each comprising p elements. The elements are electrically interconnected in parallel in each of the modules by means of plates connected to the bottoms of the cathode tanks and anode tanks; each of the plates comprises a substantially central bore. The invention is implemented for propelling all electric vehicles. 8 figures.

PERFORMANCE AND TESTING

10513 (AD-A—011027/0ST) **Studies related to the low temperature recharge of the lead—acid system.** Garnder, C.L.; Rocheleau, F. (Defence Research Establishment, Ottawa, Ontario (Canada)). Jan 1975. 23p. (DREO-TN—75-1). NTIS, PC A02/MF A01.

The effects of temperature and sulfuric acid concentration on the formation of persulfuric acid at a lead dioxide electrode were studied, along with the recharge properties of the electrode. The effect of electrolyte pH was also examined. Based on these results, some conclusions were drawn as to the nature of the low-temperature recharge problem of the lead—acid battery.

10514 Method for selective recovery of cadmium from cadmium-bearing waste. Reinhardt, H.; Ottertun, H.D.; Rydberg, J.H.A. (to Nife Jungner AB). US Patent 4,053,553. 11 Oct 1977. Priority date 28 Jan 1975, Sweden. 12p.

A method for the selective recovery of cadmium, nickel and cobalt from a nickel—cadmium battery waste comprises the following steps: (A) leaching the waste with an ammoniacal carbonate solution to form an aqueous ammoniacal carbonate solution containing cadmium, nickel and cobalt (II) ammine complexes and a leaching residue--any iron in the waste is in the leaching residue; (B) adding air to the aqueous ammoniacal carbonate solution to oxidize the cobalt (II) ammine complex to cobalt (III) ammine complex; (C) contacting the resulting aqueous ammoniacal carbonate solution with a substantially water insoluble organic solution which contains a hydroxyoxime which forms a nickel compound readily soluble in the organic solution with any nickel present but which does not affect cadmium and cobalt (III) (nickel is thereby removed); (D) precipitating the cadmium as a carbonate by removing ammonia from the aqueous ammoniacal carbonate solution and then removing the cadmium in the form of a carbonate; (E) withdrawing a portion of the aqueous ammoniacal carbonate solution from the preceding step after precipitation of cadmium and precipitating the cobalt by removal of ammonia; (F) returning the ammonia from the preceding step to the cadmium-free solution in step (D) and replacing lost carbonate ions by adding carbon dioxide in gaseous form--the resulting solution can then be reused in step (A); (G) stripping the nickel compound in step (C) by washing with an aqueous solution of sulfuric acid to strip the nickel as nickel sulfate. The organic solution stripped of nickel can thereafter be reused in step (C). 3 figures, 5 tables.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 10505, 10508, 10510

10515 (AD-A—012098/0ST) **Solid electrolyte battery materials.** Huggins, R.A. (Stanford Univ., Calif. (USA). Center for Materials Research; Office of Naval Research, Arlington, Va. (USA)). 31 Mar 1975. 187p. (CMR—75-10). NTIS, PC A09/MF A01.

The following topics are treated: oxide fabrication via controlled oxidation of polymer precursors; the electrical response of some lithium silicates and aluminosilicates; Ramsdellite structure lithium titanate and lithium germanates; graphite intercalation compounds; calculation of motional activation energies for interstitial ions in the rutile structure using a minimum energy path model; publications and presentations related to this program.

10516 (AD-A—022952/6ST) **Electrochemistry of some new alkaline battery electrodes.** Pickett, D.F.; Bishop, W.S.; Marsh, R.A. (Air Force Aero-Propulsion Lab., Wright-Patterson AFB, Ohio (USA)) Feb 1976. 46p. (AFAPL-TR—75-79). NTIS, PC A03/MF A01.

New alkaline battery electrodes used in cells such as nickel oxide—cadmium, nickel oxide—hydrogen, nickel oxide—zinc, and silver oxide—zinc were developed as a result of contracted and in-house research at the Air Force Aero-Propulsion Laboratory. Cathodic hydroxide precipitation techniques are used for preparation of nickel oxide and cadmium electrodes. Bipolar silver oxide—zinc electrodes are fabricated by spray deposition-sintering and vapor deposition techniques. Novel methods for preparation of dry-charged nickel oxide electrodes for reserve-type nickel oxide—zinc batteries are being investigated. One technique involves charging conventional sintered, vacuum-impregnated electrodes, then removing electrolyte with a distilled water wash. Drying is performed in vacuo. The plates yield rated capacity upon activation, but on long-term dry storage data are available. Secondary nickel oxide electrodes, prepared by cathodic precipitation techniques, appear far superior to other nickel oxide electrodes because of their reduced thickening with charge—discharge cycling at deep depths of discharge and their good charge acceptance at high temperatures. The silver oxide—zinc electrode fabrication techniques made construction of a multicell pile for high-power applications feasible. Minor problems such as anomalous gassing were incurred but appear capable of solution.

10517 **Method of preparing iron disulfide electrodes.** Dunning, J.S.; Bradley, T.G. (to General Motors Corp.). US Patent 4,053,978. 18 Oct 1977. Filed date 2 Dec 1976. 6p.

Iron disulfide electrodes are prepared by slurrying the FeS_2 in molten sulfur, spreading the slurry into FeS_2—S sheets, solidifying the FeS_2—S sheets, sandwiching the FeS_2—S sheets between porous current-conductor sheets, and heating the thus-formed sandwich to volatize away the sulfur. Flexible FeS_2—S sheets are obtained by heating the slurry to about 300°C and then rapidly quenching them in H_2O. 2 figures.

10518 **Contact between metal can and carbon/graphite fibers in sodium/sulfur cells.** Breiter, M.W. (to Electric Power Research Inst., Inc.). US Patent 4,053,689. 11 Oct 1977. Filed date 20 Dec 1976. 4p.

In sodium/sulfur batteries, electrical contact is maintained between the sulfur, which is nonconductive, and an aluminum container or other external electrical conductor by having electrical contact between the sulfur and conductive carbon fibers and/or mat which contact a molybdenum- or chromium-coated surface of an aluminum conductor. A terminal portion of the aluminum conductor is uncoated and is employed for making electrical contact to the external conductor. A battery configuration of particular interest has a central β-alumina tube which may serve as the sulfur or sodium container surrounded by sodium or sulfur, respectively. 5 figures.

10519 **Nickel activation battery component.** Gutridge, I.P. (to International Nickel Co.). US Patent 4,053,694. 11 Oct 1977. Priority date 13 Nov 1973, United Kingdom of Great Britain and Northern Ireland (UK). 6p.

A process for activation of foil or sheet substrate to render it suitable for electrochemical use comprises first anodically treating the impervious substrate in an aqueous ammoniacal solution of nickel nitrate and thereafter cathodically treating the anodically treated substrate in an aqueous acid electrolyte containing nickel ions and reducible ions, the redox potential of which is more positive than the discharge potential of nickel ions. 5 figures, 3 tables.

10520 **Epoxy sealed lead battery probe.** Oxenreider, T.R. (to General Battery Corp.). US Patent 4,053,686. 11 Oct 1977. Filed date 13 Sep 1976. 8p.

An electric storage battery is described which has a case to retain electrolyte up to a given preferred level, a cover for retaining the electrolyte within the case, a probe for sensing the preferred level of the electrolyte, and resin means for chemically sealing at least a portion of the probe with the cover. The cover has defined in it at least one bore, which comprises at least one constricted section; the probe is disposed through the cover. In addition, there is disclosed an interrelation between the remainder of the probe and the bore that allows for the introduction of resin between the surfaces of the probe and bore to create an effective seal between the probe and battery cover. Finally a unique configuration of probe and bore is disclosed which produces a strong electrolyte-tight seal between the probe and battery cover. 3 figures.

10521 **Electric accumulator cell with at least one dissoluble electrode.** von Krusenstierna, O. (to Aktiebolaget Tudor). US Patent 4,052,541. 4 Oct 1977. Priority date 15 Jul 1975, Sweden. 8p.

An improvement in electric accumulator cells having a dissoluble electrode (e.g., a zinc electrode) and a counter-electrode (e.g., nickel electrode) is disclosed. The dissoluble electrode is formed by a central layer having outer layers disposed on either plane side thereof. The outer layers are generally smaller in planar size than the central layer, and preferably all of the layers are porous, perforated, or netlike. The multilayer electrode has particular utility in a cell in which the dissoluble electrode and/or separator disposed between the dissoluble electrode and counter-electrode are vibrated in the plane of the electrode. Dendrite growth and shaping of the deposited active material are substantially minimized, and improved cell life is obtained.

10522 **Substantially non-gassing alkali resistant battery separator and method of producing same.** Smatko, J.S. (to McDonnell Douglas Corp.). US Patent 4,052,540. 4 Oct 1977. Filed date 16 Nov 1970. 16p.

Production of an inorganic, porous, sintered battery separator substantially eliminating formation of gas when in contact with a zinc electrode is described. A long cycle life of a high-energy-density battery, such as a silver—zinc battery, results. The material is produced according to one embodiment by initially firing a mixture of magnesium-bearing material, e.g., MgO, zinc-bearing material, e.g., ZnO, and silica (SiO_2) at a temperature in the range of about 1,100 to about 1,500°C to produce a magnesium silicate—zinc silicate composition, granulating and compacting the composition into plaques, and sintering the compacted plaques at a temperature ranging from about 1,000° to about 1,300°C to produce porous sintered separator members, in the form of a sintered solid solution of magnesium silicate and zinc silicate, having good transverse strength and low resistivity. 1 figure, 1 table.

10523 **Battery recharging meter.** Vizza, J. US Patent 4,052,655. 4 Oct 1977. Filed date 10 Sep 1975. 4p.

A meter stand for use in recharging the batteries of battery-powered vehicles includes a register to indicate the cost of the recharging service and a coin-operated locking means to prevent disconnection of the vehicle from the meter until the cost of the recharging service has been paid. 6 figures.

10524 **Battery charging system.** Lavell, M.; Wilson, D.P. US Patent 4,052,656. 4 Oct 1977. Filed date 14 Aug 1975. 20p.

A description is given of apparatus and method for charging storage batteries by continuously sensing particular battery parameters and controlling the charging current in response thereto to charge a single battery or a string of batteries. The batteries are charged in a charging cycle including a high charging current stage, a controlled charge tapering stage, and a finishing current stage, so that the batteries are charged in as short a time as possible without injuring the batteries, regardless of their age or condition. 4 figures, 2 tables.

10525 **Manufacture of tubular type battery plates.** Foulkes, S.C. (to Chloride Group Ltd.). US Patent 4,051,876. 4 Oct 1977. Priority date 23 Dec 1974, United Kingdom of Great Britain and Northern Ireland (UK). 32p.

There is disclosed a method for preparing enveloped plates for batteries. An active material composition containing liquids is introduced into the porous envelope of the plate when the envelope is assembled on the current-conducting element of the plate. The active material composition is an alkaline active material composition with a liquid content such that active material is filtered out by the porous envelope, while liquids pass out through the walls of the porous envelope. There is also disclosed a novel alkaline electric storage battery electrode comprising a porous envelope enclosing within it particulate active material which is electrochemically active under alkaline conditions. The porous envelope is capable of filtering out a bed of active material from an aqueous slurry of the active material containing 0.5 parts of the active material per part of water. 15 figures, 8 tables.

10526 **Battery vent plug.** Devitt, J.L. (to General Battery Corp.). US Patent 4,052,534. 4 Oct 1977. Filed date 3 May 1973. 8p.

Various improved battery vent plugs utilizing a slit resilient acid-resistant diaphragm bi-directional valve which opens temporarily automatically under gaseous pressure serve to minimize battery fluid loss. 7 figures.

10527 **Battery assembly.** Beatty, T.R. (to Union Carbide Corp.). US Patent 4,049,882. 20 Sep 1977. Filed date 11 Feb 1976. 6p.

The battery assembly incorporates a chemical tab connection which has a multiplicity of projections for penetrating an electrode to form a mechanical joint and for simultaneously establishing electrical contact with the electrode through such joint. 8 figures.

10528 Construction for solid electrolyte in sodium/sulfur battery. Mitoff, S.P. (to Electric Power Research Inst., Inc.). US Patent 4,049,885. 20 Sep 1977. Filed date 12 Oct 1976. 4p.

A high-surface-area, short-diffusion-path sodium/sulfur cell is provided having a plurality of half-cells in spaced-apart planes extending through the block in a first direction with a second group of half-cells in the planes intermediate the planes of the first group of half-cells extending through the block in a direction normal to the direction of the first group of half-cells. The construction is strong and stable, provides for large surface area contact with the cell reactants, and avoids narrow passageways which result in high resistance. The sodium and sulfur can be circulated through the active cell volume during charging and discharging of the battery to permit large storage capacity. Current collection can be achieved by employing graphite fibers twisted between aluminum wires, with the aluminum wires welded to an aluminum manifold. 6 figures.

10529 Hermetically sealed alkali metal battery container. Heintz, W.K. (to Ford Motor Co.). US Patent 4,049,889. 20 Sep 1977. Filed date 1 Sep 1976. 6p.

The invention is embodied in a hermetically sealed alkali metal battery container. Two opposed outer metallic casings are hermetically sealed to a ceramic ring which supports an inner casing of a solid alkali ion-conductive material. The hermetic seal is accomplished by means of annular ridges on metal rings associated with the two outer casings and a pair of washers interposed between the annular ridges and respective top and bottom surfaces of the ceramic ring. 2 figures.

10530 Battery charging circuit. Bosik, B.S. (to Bell Telephone Labs., Inc.). US Patent 4,048,551. 13 Sep 1977. Filed date 5 Dec 1975. 12p.

A single-channel carrier system for telephone service is disclosed including at the remote terminal a battery charger for charging a battery which powers the carrier electronics at the remote terminal. A ringing generator and supervisory circuits are disclosed to provide normal telephone supervision on the carrier-derived channel. The battery charger includes a dc-to-dc converter to increase the rate of battery charging and an interface unit to minimize the effect on the telephone line by the charger. In one embodiment, the interface unit disconnects the charger to permit leakage testing of the line. 11 figures.

10531 Battery electrode sheaths. Sundberg, E. (to Aktiebolaget Tudor). US Patent 4,048,398. 13 Sep 1977. Filed date 2 Sep 1976. 6p.

A sheath for a storage battery electrode comprises a braid or weave of inorganic fiber threads and a plurality of axial threads extending along the axial length of the sheath and forming crossing points with the inorganic threads. The axial threads comprise a mixture of at least two thermoplastic materials having different softening temperatures. Fabrication of the sheath involves tensioning the sheath and heating it to a temperature sufficient to soften the thermoplastic fiber having the lower softening temperature to bond the latter to the inorganic fibers at the crossing points. The heating is sufficient to weaken the thermoplastic fibers having the higher softening temperature to enable the latter to be only slightly elongated under tension, to enable internal stresses of the axial threads to be substantially equalized. 4 figures.

10532 Double wall multitube bags for enclosing the active material of positive plates in electric lead batteries. Terzaghi, G. (to Mecondor S.p.A.). US Patent 4,048,399. 13 Sep 1977. Priority date 26 Mar 1975, Italy. 8p.

A multitube sheath or bag for enclosing the active material of positive plates in electric lead batteries is described. The bag comprises four discrete fabrics simultaneously made on a shuttleless loom. The fabrics are interconnected along parallel lines by means of one or more weft threads. In this way, every side of each tube comprises a double wall formed by two different fabrics, of which the inner fabric has weft threads of glass yarn and warp threads of synthetic yarn, the number of weft threads being much larger than that of warp threads at a same length of the fabric involved. The two outer fabrics are essentially made of synthetic yarn. 7 figures.

10533 Electrode for a rechargeable electrochemical current source, and method of making same. Sandera, J.; Calabek, M.; Cenek, M.; Kaiab, F.; Koudelka, V.; Kouril, O.; Malik, J.; Vanacek, J. (to Prazska akumulatorka, narodni podnik). US Patent 4,048,406. 13 Sep 1977. Filed date 21 May 1975. 4p.

This current source employs an electrolyte, an electrode having an electrically conductive collector, and a mixture of an active mass in a plastic material distributed over the collector and sintered thereon to form an integral electrode element. The electrode has a porous layer of material covering at least a substantial portion of its active surface. The porous layer is made of an electrically non-conductive material which is chemically inert with respect to the electrolyte. The plastic material is bonded to the porous layer by being sintered to it. 1 figure.

10534 Electrode for primary or secondary battery and method for producing such an electrode. Boter, P.A. (to U.S. Phillips Corp.). US Patent 4,048,407. 13 Sep 1977. Priority date 19 Sep 1975, Netherlands. 4p.

An electrode for a primary or secondary battery is described. Its electrochemically active part comprises a porous layer of a hydride of an intermetallic compound which is sintered to a metallic support, the pores being filled with a hydrophylic water-insoluble macromolecular material. 2 figures.

10535 Lithium electrode for electrical energy storage device. Lai, S.C. (to Rockwell International Corp.). US Patent 4,048,395. 13 Sep 1977. Filed date 18 Aug 1976. 16p.

An improved lithium electrode structure comprises an alloy of lithium, silicon, and iron in specified proportions and a supporting current-collecting matrix in intimate contact with the alloy. The lithium electrode of the present invention is utilized as the negative electrode in a rechargeable electrochemical cell. 5 figures, 4 tables.

10536 Secondary battery or cell with vitreous carbon coated graphite current collector. Ludwig, F.A. (to Ford Motor Co.). US Patent 4,048,394. 13 Sep 1977. Filed date 28 Feb 1977. 10p.

An improved secondary battery or cell consists of the following: an anodic reaction zone containing a molten alkali metal reactant-anode in electrical contact with an external circuit; one or more cathodic reaction zones containing a cathodic reactant which, when the battery or cell is at least partially discharged, is either a single-phase composition comprising molten polysulfide salts of the anodic reactant or a two-phase composition comprising molten sulfur and molten-sulfur-saturated polysulfide salts of the anodic reactant; a cation-permeable barrier to mass liquid transfer interposed between and in contact with the anodic and cathodic reaction zones; and a current collector which is at least partially exposed to the cathodic reactant and which is in electrical contact with both the cation-permeable barrier and the external circuit. The improvement is the use of a current collector comprising a graphite body bearing a coating of vitreous carbon on at least those surfaces which are exposed to the cathodic reactant. 3 figures.

10537 Substance and device for the absorption of catalyst poisoning gases out of the oxyhydrogen gas produced by lead-acid storage batteries. Lahme, N.W.; Sassmannshausen, G.C. (to Accumulatorenwerk Hoppecke-Carl Zoellner and Sohn). US Patent 4,048,387. 13 Sep 1977. Priority date 2 Aug 1972, German, Federal Republic of (F.R. Germany). 8p.

A substance, a method of producing it, and a device for using the substance in the absorption of catalyst-poisoning gases out of the oxyhydrogen gas mixture produced by lead—acid storage batteries are described. The substance causes the oxidation of the unstable catalyst-poisoning gases SbH_3 and AsH_3 to produce hydrolysis-resistant intermetallic compounds. As absorbing substances they are usable heavy-metal manganites, heavy-metal oxides, and catalytic agents. As a device, the absorbing substance is combined with an oxygen and hydrogen recombination unit. 1 figure.

10538 Method of making electric storage batteries. Edwards, W.H. (to Chloride Group Ltd.). US Patent 4,046,642. 6 Sep 1977. Priority date 11 Sep 1975, United Kingdom of Great Britain and Northern Ireland (UK). 10p.

A method of generating electrochemical activity in positive plates of Plante cells is disclosed. An agent corrosive to the unformed pure lead positive plate is incorporated in the electrolyte and the cell is charged, the corrosive agent being selected to be destroyed by the anodic conditions at the negative plate at the end of the charging cycle. Nitrate ions are preferred.

10539 Automatic resetting temperature controlled battery charging system. Alexandres, R.B. US Patent 4,045,720. 30 Aug 1977. Filed date 4 May 1976. 6p.

An automatically resetting battery charging circuit is described in which the temperature of the battery is sensed by a temperature-responsive switch to control the charging of the battery between a fast charging rate and a trickle charging rate. Two current paths are provided between a charging current source and one terminal of the battery. The temperature-responsive switch is located in one current path (the main or fast-charging path) in series with a normally closed relay contact. The relay coil which controls the actuation of the relay and the opening of the relay contact is in the second current path (the trickle-charging path) connected across the temperature-responsive switch and the relay contact. When the battery temperature exceeds a predetermined value, the temperature-responsive switch opens and causes charging current to flow through the relay coil. The relay is thus energized, opening the relay contact and keeping the main charging path open irrespective of battery temperature. Thereafter, a trickle current is delivered to the battery through the relay coil. The relay coil is deenergized and the charging circuit automatically reset for subsequent charging by disconnecting the battery or otherwise interrupting current flow through the relay coil. 2 figures.

10540 Battery charger. Fallon, W.H.; Schober, W.R. (to General Battery Corp.). US Patent 4,045,717. 30 Aug 1977. Filed date 13 Apr 1976. 4p.

In a battery charging circuit for charging a battery load characterized by having a substantial effective capacitance, a transformer is connected in a Scott T configuration, the transformer input being adapted for connection to a three-phase power line and the transformer output circuit being in a four-phase star configuration for providing a four-phase charging circuit. The transformer additionally contains a pair of ferroresonant circuits, each such circuit containing a capacitance selected to cooperate with the capacitance of the battery so as to provide the desired charging characteristic. 2 figures.

10541 Electro-chemical concentration transducer and its use to measure and control acid strength and storage battery charge. Swain, W.H. US Patent 4,045,721. 30 Aug 1977. Filed date 30 Dec 1974. 54p.

A simple and rugged transducer has an electric potential output which is a measure of the concentration of a sensed sulfuric acid. The small temperature coefficient of potential is linear and correctable. The resistance of the transducer is a strong and negative function of temperature. It is used to measure electrolyte temperature and to compensate variable characteristics of batteries and reagents. A battery is automatically charged in 2½ hours. Both transducer potential and resistance are used in a new and doubly responsive closed-loop system which regulates charging current so that it is as high as can safely be used. A battery gage conveniently shows available charge or energy at the present temperature of the battery. Chemical reagent strength is measured and controlled. The transducer uses the discovery that an electric potential of 40 millivolts exists between two electrodes--one in contact with the electrolyte of a fully charged lead—acid cell, and the other in contact with the weaker electrolyte of a discharged cell--when the electrolytes are electrolytically joined by an electrolyte in an insulated container constructed to prevent mixing of the electrolytes. The strength of different types of electrolytes is sensed in a similar structure. Theory is given and preferred transducers are described. These are matched to measuring and controlling instruments using an improved method and integrated circuit amplifier. 10 figures.

10542 Handle for plastic batteries. Hakarine, D.D. (to Gould Inc.). US Patent 4,042,762. 16 Aug 1977. Filed date 11 Nov 1975. 4p.

Straps are molded integrally with and hinged to opposite sides of a plastic battery case and may be swung upwardly to form a handle for enabling easy carrying of the battery. In one embodiment, the straps are formed with hand holes and are grabbed individually when the battery is carried. In another embodiment, the straps are secured together at their ends and define a bail-type handle for the battery. 4 figures.

10543 Battery. Borello, D. US Patent 4,042,754. 16 Aug 1977. Filed date 20 Oct 1976. 4p.

A battery is described in which, to improve its discharging performance, the liquid electrolyte is maintained at a specific gravity that is optimum for electrical conductivity, a magnetic flux is imposed upon the battery plates, and other such conditions which also favor electrical conductivity, saturation, storage, and desaturation are maintained. 2 figures.

10544 Zinc electrodes and methods of making same. Berchielli, A.S.; Chireau, R.F. (to Yardney Electric Corp.). US Patent 4,041,221. 9 Aug 1977. Filed date 27 Jul 1976. 6p.

Improvements in cell capacity maintenance and reductions in electrode shape change are obtained in rechargeable zinc (-) cells by the inclusion of limited amounts of a titanate compound in the negative zinc electrode. 3 tables.

10545 Mixed conductors of graphite, processes for their preparation and their use, notably for the production of electrodes for electrochemical generators, and new electrochemical generators. Armand, M.B. (to Agence Nationale de Valorisation de la Recherche (ANVAR)). US Patent 4,041,220. 9 Aug 1977. Priority date 18 Aug 1972, France. 14p.

New mixed conductors are described which result from the insertion of an alkali element into the lattice of an intercalation compound of graphite and of a product M'/sub y/X/sub z/: M' is a transition metal such as Ti, V, Cr, Mn, Fe, Mo; X is a nonmetallic electronegative atom such as O, S, F, Cl, or Br; y and z have the values of the indices in the product M'/sub y/X/sub z/. These mixed compounds are useful for the manufacture of positive electrodes of electrochemical generators. 2 figures.

10546 Alkaline electric storage batteries. Hewitt, A.T. (to Chloride Group Ltd.). US Patent 4,041,212. 9 Aug 1977. Priority date 21 May 1975, United Kingdom of Great Britain and Northern Ireland (UK). 6p.

The plates of each polarity of an alkaline battery are connected by a sheet metal connector which passes through a slot in the bottom of a well formed in the battery lid, and which is supported by means of a pair of ears projecting from the connector which rest on the lid. Each connector is secured against vertical movement by abutment of the ears against the upper surface of the lid and by abutment of a respective plate strap to which each connector is welded against the lower surface of the lid. Horizontal movement in one plane is prevented by the provision of a shoulder on the lid on each side of each ear, and in the other plane by abutment of the connector, or the ears, against the edge of the well or a further shoulder, respectively. The slots are sealed by means of a sealant which fills the wells. Upstanding ribs are provided on the upper surface of the lid so as to increase the length of the leakage path between neighboring cells. 8 figures.

10547 Method for forming solid electrolyte composite. Kormanyos, K.R.; McCollister, H.L.; White, P.L. (to Owens-Illinois, Inc.). US Patent 4,041,215. 9 Aug 1977. Filed date 5 Apr 1976. 6p.

A solid electrolyte composite is provided which is suitable for use as the separating member between a sodium reservoir source and a sulfur reservoir source in a sodium--sulfur battery. The solid electrolyte composite is manufactured by providing a membrane of a crystalline ionic conductive sodium polyaluminate on a portion of a porous, anhydrous crystalline supporting body consisting of α-Al_2O_3. The sodium polyaluminate is initially applied in the form of a precursor which is then subsequently heated to form the ionic conductive crystalline sodium polyaluminate membrane. 1 figure.

10548 Separator for alkaline storage batteries. Axelrod, S.S.; Belozerov, V.G.; Gershman, M.B.; Margolin, E.G.; Shapot, M.B. US Patent 4,041,218. 9 Aug 1977. Filed date 7 Jan 1976. 4p.

A separator for alkaline storage batteries is described which is a reticular flexible envelope arranged about an electrode, the envelope being formed by interlacing rods. The first group of rods is arranged substantially parallel with respect to the longitudinal axis of the electrode, and the second group of rods is arranged with an inclination relative to the first group of rods. A thickness ratio of the first rod group and the second rod group is within the range of about 2 to 4. 2 figures.

10549 Alkali metal battery structure. Heintz, W.K.; Lingscheit, J.N. (to Ford Motor Co.). US Patent 4,048,393. 13 Jul 1977. Filed date 3 Sep 1976. 6p.

The invention is embodied in a structure for containing an alkali metal battery. A closed metal housing includes a flange having an opening. An electronically and ionically insulating ceramic member is bonded to an exterior surface of the metal housing and encircles the opening through the flange thereby to define a passageway which is an extension of the opening. An electrically insulating, cation-permeable barrier to mass liquid transfer has an interior volume and an exterior surface area. The cation-permeable barrier is bonded to the ceramic member in such a manner that the interior volume of the metal housing, the passageway defined by the ceramic member, and the interior volume of the cation-permeable barrier form a first closed electrode reaction zone. A container, including a structure bonded to the ceramic member, defines a closed container which encloses the exterior surface area of the cation-permeable barrier, the volume between the interior surface area of the container and the exterior surface area of the cation-permeable barrier forming a second closed reaction zone. 4 figures.

10550 Compartmented electrode structure. Vissers, D.R.; Shimotake, H.; Gay, E.C.; Martino, F.J. (to Energy Research and Development Administration). US Patent 4,029,860. 14 Jun 1977. Filed date 12 Feb 1976. 8p.

PAT-APPL-657,525.

Electrodes for secondary electrochemical cells are provided with compartments for containing particles of the electrode reactant. The compartments are defined by partitions that are generally impenetrable to the particles of reactant and, in some instances, to the liquid electrolyte used in the cell. During cycling of the cell, reactant material initially loaded into a particular compartment is prevented from migrating and concentrating within the lower portion of the electrode or those portions of the electrode that exhibit reduced electrical resistance. 3 figures, 1 table.

APPLICATIONS

REFER ALSO TO CITATION(S) 10660, 10661

ENERGY MANAGEMENT AND POLICY

REFER ALSO TO CITATION(S) 10752

10551 (BNL—50633) **Planner's energy workbook: a manual for exploring relationships between land use and energy utilization.** Car-

roll, T.O.; Nathans, R.; Palmedo, P.F.; Stern, R. (Brookhaven National Lab., Upton, N.Y. (USA); State Univ. of New York, Stony Brook (USA). Inst. for Energy Research). Jun 1977. Contract EY-76-C-02-0016. 129p. Dep. NTIS, PC A07/MF A01.

It has been clear that the magnitude and character of a region's energy requirements are intimately related to the spatial configuration and mix of land use activities. To the degree to which they can shape the future configurations of residential, commercial, industrial, and transportation activities, local governments and their planners must give serious consideration to the energy implications of those configurations in the light of future social goals and requirements. This Planner's Energy Workbook describes a set of procedures that can be used to carry out community and regional energy analyses. The choice of land use activity parameters and their relation to energy use characteristics are associated with the normal planning concepts of land use density, type of residential development, commercial floorspace, industrial sales and employment, and shopping and work trip lengths. At the same time these energy related intensity coefficients are expressed in a form that permits the analysis of short-term conservation strategies such as the retrofit of insulation and the introduction of new technologies such as solar energy. An integrating framework is provided to construct total community or area energy consumption profiles and future needs; to examine compatibility between area requirements and the energy supply-distribution system serving the area; and to evaluate the implications for energy use of the physical configuration of urban, suburban and rural areas. Two cases illustrate the application of this Workbook. The Long Island area is representative of major suburban regions throughout the U.S. which have undergone major growth and development. A community redevelopment design in Tuscon, Arizona is typical of rapid and major land use development within the environs of an existing city.

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 9571, 9760, 10271, 10551, 10557, 10559, 10580, 10582, 10608, 10619, 10629, 10631, 10637, 10640, 10641, 10644, 10645, 10980

10552 (BNL—22969) **Energy systems analysis and development.** Palmedo, P.F. (Brookhaven National Lab., Upton, N.Y. (USA)). 5 Jul 1977. Contract EY-76-C-02-0016. 23p. (CONF-770742—1). Dep. NTIS, PC A02/MF A01.

From Workshop on systems development; Seoul, Republic of Korea (12 Jul 1977).

The nature of energy problems, their technical and social complexity, and their long time scale places a high priority on broad-scale systems analysis as a basis for formulating national energy policy. A number of models have been developed recently that can be used for such analysis. The Federal Energy Administration PIES Model and the Brookhaven National Laboratory models are discussed briefly as examples. Models, however, as they currently exist must be used with caution in national planning, both because of their technical limitations and because of the restricted part of energy issues that admit to quantification. Suggestions are made for further extension of current analytical approaches.

10553 (IIASA-CP—77-2) **Methods of systems analysis for long-term energy development.** Kononov, Y. (ed.). (International Inst. for Applied Systems Analysis, Laxenburg (Austria)). Mar 1977. 43p. Dep. NTIS, PC A03/MF A01.

A constructive systems approach to long-term energy-development forecasting (for 30 to 40 years) is elaborated, and the main methods and mathematical models for implementing it are proposed, namely: (1) an intersector model and method for long-term forecasting of basic indices of economic growth and national economic estimation of energy-development strategies; (2) an iterative scheme and optimization model for elaborating possible energy-development strategies and comparison of tendencies in science and technology; and (3) a statistical model for forecasting final energy demand based on existing dynamics of the main indices of economic growth. These models and methods are tested on preliminary information.

10554 (P—5912) **Energy choices and preference relation paradoxes.** Augenstein, B.W. (Rand Corp., Santa Monica, Calif. (USA)). Jul 1977. 8p. Corporation, Santa Monica, CA $1.50.

An analysis is presented of how advocates propose their energy choice to be the preference choice. The author uses nuclear, coal, and solar technologies as examples. The arguments do not do extreme violence to any technology and none is unrealistic. Primary, secondary, etc. priorities vary and the author presents a method to codify the preference relations. The value judgments assumed by the several groups simply weigh differenty three primary factors--cost, environmental hazards, and proliferation risk. The author concludes that while future research and development might make more precise the estimates of how one ought to measure these three factors, there is no guarantee that the weighting in the value judgments will be grossly perturbed, and the initial intuitive weighting might be reinforced. (MCW)

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 10567, 10594, 10596, 10602, 10605, 10627, 10633, 10639, 10647, 10980

10555 (AED-CONF—77-027-006) **Heating costs and problems of renting. Prospects on future requirements on the housing market.** Weidlich, B. (Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.)). Mar 1977. 19p. (In German). (CONF-770378—6). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 3. meeting of the Deutsche Gesellschaft fuer Sonnenenergie e.V. on heating with sun 2 - house technology under practical aspects; Munich, F.R. Germany (3 Mar 1977).

The article deals with the question of whether rising energy prices are a determining factor in house renting. For a high number of family budgets, heating costs have already reached a 40 percent share of the whole rent. From the view of these family budgets, heat costs can be a criterion in renting a house, especially since the house market has a reservoir of 300,000 to 350,000 houses to rent.

10556 (CONF-7605161—, pp 30-34) **Engineer and urban renewal.** Chapman, A. (Univ. of Sydney). 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

From a discussion of the activities by various bodies in Sydney during the Green Ban era of 1972/73/74, the paper proceeds to look at the problem of urban renewal and in particular the high, medium, and low-rise arguments. Following a broad look at the quality of life in each of these urban types, the paper examines later developments in other world centers. Finally the paper calls for a more positive role by the engineer.

10557 (CONF-7605161—, pp 35-39) **Urban growth centre economic and infrastructure planning in practice.** Fowler, J.C.; Gillett, J.A. (Kinnaird Hill deRohan and Young Pty. Ltd., Melbourne). 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

This paper presents an outline of the economic planning methods developed and used by the authors in carrying out planning studies for urban growth in cities and new towns in Australia and New Zealand. A method of household formation analysis is described. This method can provide reliable estimates of the demand for dwellings during the next two decades because most of the potential household formers over than period are already born and constitute the existing population under 20 years of age. An urban economic development model, designated DEVMOD, has been developed to allow planners, policymakers and managers of urban growth to assess the level and timing of construction activity, cash flows, and financial implications of a managed growth program. The management task in the early years of a growth center is a difficult one and requires that growth rate targets be feasible in terms of construction industry resources. The importance of the construction industry, and its multiplier effect, to employment and the fulfillment of development objectives is discussed. The paper describes the way in which information derived from the planning process is combined by Economists and Engineers into both action plans and financial plans. These plans provide planners and policymakers with a method by which the implications of various planning options can be tested and compared.

10558 (CONF-7605161—, pp 46-50) **Terrain evaluation, soil assessment and infrastructure costing in the strategic planning of new cities.** Neil, R.C.; Scales, P.J. (Kinnaird Hill deRohan and Young Pty. Ltd., Melbourne). 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

The most effective way in which engineering data can be used in the planning process at the strategic level is in terms of the feasibility of development and the relative cost of alternative solutions. These assessments can be performed by any experienced engineer utilizing accepted techniques of terrain evaluation, soil assessment, and costing. The planner can therefore be given rapid evaluations of the economic and physical consequences of applying his criteria of development to any particular area of land.

10559 (COO—2893-3) **Energy conservation and employment impacts of changes in technology and consumption. Annual progress report for period April 21, 1976—April 20, 1977.** Hannon, B.M.; Segal, B.Z.; Brodrick, J.; Ford, C.; Joyce, J.; Kakela, P.; Perez-

Blanco, H. (Illinois Univ., Urbana (USA). Center for Advanced Computation). May 1977. Contract EY-76-S-02-2893. 191p. Dep. NTIS, PC A09/MF A01.

An energy and employment input-output model was used to select and investigate several industrial sectors of the economy in order to determine the potential for energy conservation in these areas and the resulting impacts on total U.S. energy consumption. Where possible, employment impacts were also computed. In iron and steel production, energy and labor costs of taconite and natural ore processing were compared. Although in the preparation stage the taconite process was found to be more energy- and labor-intensive than the natural ore process, when the blast furnace stage was considered, the former process appeared to use less total energy and less labor than the latter. In addition, the Basic Oxygen, Open Hearth, and Electric Arc processes of steel making were analyzed, and the last of these proved to be the least energy-intensive. In paper production, an analysis of the energy cost of various methods of producing paper was initiated, with various recycling scenarios considered. Recycling was found to be more energy-efficient than other processes. The potential for energy conservation through cogeneration was examined for the chemical, petroleum refining, tire, paper, and food industries. Certain of these were found to have substantial potential for energy savings; effects upon total U.S. energy consumption were also estimated. In residential space conditioning, an analysis of the use of insulation and solar energy in residential homes was begun. Use of additional insulation in the current housing stock was found to be an effective energy conservation option.

10560 (EPRI-EA—433(Vol.1)) **Fuel and energy price forecasts: quantities and long-term marginal prices. Final report. Volume I.** (SRI International, Menlo Park, Calif. (USA)). Sep 1977. 169p. Dep. NTIS, PC A08/MF A01.

SRI International (formerly Stanford Research Institute) prepared forecasts of long-term marginal fuel and energy prices over the period 1985 to 2000. These projections are shown in constant 1975 dollars on a regional basis for the United States. The major sources of energy analyzed are coal, uranium, crude oil, "syncrude" (produced from coal or oil shale), petroleum products, natural gas, and synthetic gas. Prices are shown at different levels of the energy system, e.g., from the point of production through consumption. Prices of delivered fuels are presented for four sectors: electric power generation, residential/commercial, industrial, and transportation. Because all fuels in the energy system are interrelated, the emphasis in the study was to specify these relationships and to forecast prices (and quantities) at every level of the energy system. This was done within the framework of the SRI National Energy Model that explicitly models primary energy production and conversion, transportation and distribution, and end-use conversion.

10561 (LA—6927-C) **Navajo Nation energy conference.** Young, F. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1977. Contract W-7405-ENG-36. 89p. (CONF-7705100—). Dep. NTIS, PC A05/MF A01.

From Navajo nation energy conference; Tsaile, Arizona, USA (2 May 1977).

The Navajo Energy Conference was conducted for individuals who are interested in problems associated with energy conservation and utilization, and social-costs problems related to the process of energy exploitation. Current technology and possibilities for new science to show the way toward improving energy utilization technology was examined. Critical issues associated with the process of energy exploitation such as policies on taxation, water utilization, environment, and development financing were discussed. The Conference was designed to point planners in the Navajo community toward both immediate applied research and more long-range exploratory research problems. The objectives were to be realistic and critical and to give the attendee an increased and genuine understanding of the basic concepts and principles associated with the total process of energy exploitation. The Conference provided an opportunity for economic development planners from the Navajo community such as the Navajo Tribal Council and the Navajo Tribal Administration to meet with a selected group of economic development researchers from both the scientific and university communities who conducted specific studies on Navajo energy and energy-related issues.

10562 (ORO/5009—1) **Development of a comprehensive community energy management plan for the City of Hobbs, New Mexico.** (Oklahoma Univ., Norman (USA). Center for Economic and Management Research). Mar 1977. Contract EY-76-S-05-5009. 208p. Dep. NTIS, PC A10/MF A01.

A study was undertaken to develop a comprehensive energy plan for the city of Hobbs, New Mexico. The development of a procedure for evolving the energy plan and the energy plan itself were equally important segments of the study and are described in detail. Data for Hobbs, N.M. on geology, topography, climate, population, economic characteristics, industries, land use, housing, transportation systems, present energy consumption patterns, and energy sources are discussed. The energy management plans for time periods ending in 1977, 1980, and 1985 and mechanisms for implementing these energy plans are presented. (LCL)

10563 (ORO/5009—1(App.)) **Development of a comprehensive community energy management plan for the City of Hobbs, New Mexico. Appendices.** (Oklahoma Univ., Norman (USA). Center for Economic and Management Research). 1977. Contract EY-76-S-05-5009. 459p. Dep. NTIS, PC A20/MF A01.

Six appendices to the report on the development of a comprehensive community energy plan for the city of Hobbs, N.M. are included in this volume. The subjects of these appendices are: technical data on energy sources, energy consumption, and feasibility of using solar energy for power generation; energy demand projections; computer tabulations of energy consumption by the residential, commercial, industrial and transportation sectors; analysis of residential energy consumption for heating, air conditioning, appliances, etc. and the potential for energy conservation in residences; city ordinances pertaining to energy matters; and maps. (LCL)

10564 **Energy II: a bibliography of 1975—1976 social science and related literature.** Morrison, D.E.; Bemis, V.; Frankena, F.L.; Buttel, F.H.; Galin, J.; Mejorado, O.; Cardinal, J. (comps.). New York; Garland Publishing, Inc. (1977). 271p.

This volume updates Energy: A Bibliography of Social Science and Related Literature (Garland, 1975) from the date the earlier manuscript was completed in January, 1975. It represents a special attempt to include the very large number of recently published behavioral and empirical studies made in the context of the 1973-74 energy crisis. Covering all relevant works in English, the material deals with the way in which individuals, families, communities, businesses, and nations have reacted and adjusted to less energy and higher energy prices. The over 2,000 entries are cross-referenced into 75 categories in margin keywords. This guide is a fundamental reference bibliography for students, teachers, researchers, policy-makers, and lay persons involved in attempting to understand the crucial social dimensions of the energy problem. See also "Energy Guide: A Directory of Information Resources," another Garland publication.

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 9649, 9655, 9656, 9675, 9676, 9677, 9678, 10551, 10558, 10572, 10613, 10903, 10909, 10912, 10913, 10980

10565 (CONF-7605161—, pp 302-306) **Engineer's role in the environmental crisis.** Wheway, R.T. (Univ. of Wollongong, Australia). 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

Industrialization, urbanization, and the population explosion have resulted in increased pressures on the ecological system of nature and led to the environmental crisis. Some of the symptoms of this crisis are the major pollution problems of air, water and noise together with problems of solid waste disposal and the energy crisis. This paper suggests roles which the engineer can play in this crisis. Specific contributions are in the solution of pollution problems and in education of engineering undergraduates.

10566 (LBL—6831(Vol.2)) **Distributed technologies in California's energy future: A preliminary report. Volume 2.** Christensen, M.; Craig, P.; McGuire, C.B.; Simmons, M. (eds.). (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; California Univ., Berkeley (USA); California Univ., Davis (USA); California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1977. Contract W-7405-ENG-48. 381p. Dep. NTIS, PC A17/MF A01.

The chapters in Volume 2 of Distributed Energy Systems in California's Future are: Environmental Impacts of Alternative Energy Technologies for California; Land Use Configurations and the Utilization of Distributive Energy Technology; Land Use Implications of a Dispersed Energy Path; Belief, Behavior, and Technologies as Driving Forces in Transitional Stages--The People Problem in Dispersed Energy Futures; Development of an Energy Attitude Survey; Interventions to Influence Firms Toward the Adoption of "Soft" Energy Technology; The Entry of Small Firms into Distributed Technology Energy Industries; Short-Term Matching of Supply and Demand in Electrical Systems with Renewable Sources; Vulnerability of Renewable Energy Systems; and District Heating for California.

10567 **Effects of pollution taxation on the pattern or resource allocation: the downstream diffusion case.** Hochman, E.; Pines, D.; Zilberman, D. (Tel Aviv. Univ., Israel). *Q. J. Econ.;* **91**: No. 4, 625-638(Nov 1977).

Giannini Foundation Paper No. 460.

The notion of "internalizing" pollution externality generated by the effluent of an upstream firm that damages the product of a downstream firm is a classical case in the literature on externalities (J. Econ. Lit., 9: 1-28(Mar. 1971)). This paper casts this problem into a von Thunen-like model and analyzes in this framework the effects of externalities on land utilization and rent along the stream. The firms' pollutants accumulate and diffuse by water streams or air-streams, damaging the production of the downstream firms or the welfare of the urban center. The polluters can be agricultural firms, mines, or any other industry located along the stream. The analysis is applied to an industry that operates in a competitive system whose share in the market is relatively small so that product and factor prices are given. The maximization of the joint net profit minus the social costs of pollution at the urban center results in Pareto optimal resource allocation. In the case treated here, the market can achieve this efficient resource allocation if the pollution externalities are internalized by taxation and the tax revenues are redistributed without affecting production decisions. The characteristics of the resource allocation and the corresponding price system, with and without this taxation, are elaborated upon.

ENERGY RESOURCES

REFER ALSO TO CITATION(S) 10567, 10720

10568 (CONF-770241—(Summ.)) **Energy policy for the U.S. food system: a subpart of a national energy policy.** (Engineering Foundation, New York (USA)). 10 Mar 1977. 28p. TIC.

From Conference on the role of energy in food production; Pacific Grove, California, USA (6 Feb 1977).

This document sets forth a national energy policy for the food system of the United States. A panel of leaders in the fields of food and energy call for this policy to be integrated into the overall U.S. energy policy. The food system has some unique characteristics that must be addressed in the overall energy policy. Considering these unique characteristics, this policy states that: (1) energy conservation must be developed and practiced in the food system; (2) fuels that are plentiful and renewable must be substituted for fuels in short supply; (3) alternative energy sources that originate from or are especially suited to the food system must be developed and used; (4) sectors of the food system must be assigned priority use of petroleum where no other fuel is available for operation of heavy-duty mobile work vehicles; and (5) sectors of the food system must be assigned priority use of natural or synthetic gas for those operations in which no substitute fuel has been developed. This five-part energy policy for the food system is realistic. It must be incorporated into the U.S. energy policy to insure a steady and reliable supply of food at a reasonable cost to consumers. The panel of experts propose ways to implement this five-part policy. 6 appendices, 12 references.

10569 (FEA/G—77/059) **Analyses of methods for the determination of water availability for energy development.** (Colorado State Univ., Fort Collins (USA); Colorado Div. of Water Resources, Denver (USA)). May 1977. 128p. Dep. NTIS, PC A07/MF A01.

The objective of this study was to develop and demonstrate how computer programs, using hydrologic, climatic, legal, and economic data, could be used to provide information for use by planners and water administrators in evaluating the impact of water availability on energy development. This included definition of the types of information needs, evaluation of existing computer program capabilities, analyses of data requirements for specific computer programs and/or to provide the specific information, selection of a group of computer programs that could provide the various levels of needed information, linking the computer programs to data sources, and applying the specific methodologies to a prototype area to demonstrate how specific information would be made available for use in the decision process.

10570 (LBL—6817) **Water conservation scenario for the residential and industrial sectors in California: potential savings of water and related energy.** Benenson, P. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1977. Contract W-7405-ENG-48. 95p. Dep. NTIS, PC A05/MF A01.

A residential and industrial water-conservation scenario for California is constructed in which water consumption is disaggregated by residential end use, industrial sector, and hydrologic study area (HSA). The energy use associated with this water use was estimated for surface and groundwater delivery, distribution, heating, and waste-water treatment. For each end use and sector, water-conservation measures were delineated and their potential savings in terms of both water and attendant energy use were estimated. This material is combined to estimate the total water and energy savings potential by end use, sector, and HSA. This potential is then compared with the reported water savings to date, and finally, some conclusions and policy implications are drawn from the results. The general findings are discussed first, followed by a listing of the more important detailed results.

10571 (NP—22466) **Resource recovery and waste reduction. Fourth report to Congress.** (Environmental Protection Agency, Washington, D.C. (USA)). 1977. 161p. GPO.

The principal developments and findings in the area of resource recovery and waste reduction are described as they apply to post-consumer municipal solid wastes. The productive use of waste material and the prevention of waste generation represent major means of alleviating the problems of solid waste, well recognized in the new law, the Resource Conservation and Recovery Act of 1976. Post-consumer solid-waste generation and resource recovery estimates, waste reduction, source separation for materials recovery, mixed-waste processing for material and energy recovery, and environmental and economic impacts of national beverage container deposit legislation are subjects discussed in subsequent chapters. (MCW)

10572 **Alternative long-range energy strategies.** Weinberg, A.M.; Rotty, R.M. (Oak Ridge Associated Universities, TN). pp 225-239 of In Global chemical cycles and their alterations by man. Stumm, W. (ed.). Berlin; Abakon Verlagsgesellschaft (1977).

From Workshop on global chemical cycles and their alterations by man; Berlin, F.R. Germany (15 Nov 1976).

See CONF-761184—.

Each of the energy modes is beset with limitations that become apparent when viewed in the long run. Fossil fuels may be limited by CO_2. Geothermal is probably a small source. Fusion may not be feasible. Fission in the long run may pose unacceptable risk. Solar may be extremely expensive. With world energy demand increasing, possibly tenfold, it seems prudent to pursue all alternatives. Though some argue that centralized energy poses a threat to human freedom, the authors point out that there may be no credible alternative to such modes of production unless population stabilizes at a relatively low value.

10573 **Coastal resources management: beyond bureaucracy and the market.** Ditton, R.B.; Seymour, J.L.; Swanson, G.C. Lexington, MA; D.C. Heath and Company (1977). 212p. .

The book covers the nature and uses of coastal resources and the allocation or management of those resources—and these must be systematically interrelated if the management of coastal resources is to be properly understood and executed. Chapter 1 aims at defining clearly the relevant conceptual materials from law, economics, political science, and administration as they fit the problem of managing the coastal arena. Also stressed is the nature of the coastal-resource arena as it actually exists. This real-world element is provided in chapters 2 and 3 on use conflicts. Protection and development problems of coastal resources are surveyed. These problems are then actively connected to potential solution mechanisms articulated in chapters 4, 5, 6, 7, and 8, where approaches from the social sciences are analyzed as to their relevance and value in solving the coastal conflicts discussed earlier. In addition, chapter 9 seeks to provide an integrated view of the management task in the form of a case study of an actual management agency. Last, this volume seeks to develop a critical perspective against which coastal management as a total activity—concept, theory, and practice—may be evaluated. Goals of environmental-resource management are explored and alternative management approaches to those goals are compared. The underlying assumption throughout the book is that the final solution to the problem of managing coastal resources lies in people's heads.

10574 **New energy sources.** Euler, K.J. (Gesamthochschule Kassel, DE). *Elektrotech. Z., A;* **96**: No. 1, 45-52(1975). (In German).

Processes for the direct conversion of various energy sources to electrical power, such as thermoelectrical devices, thermionic converters, radionucleide batteries, magnetohydrodynamics, and electrochemical fuel cells are discussed. It is believed that solar, tidal, and geothermal energy conversion are the only techniques which are likely to provide significant amounts of energy in the coming decades. It is estimated that intensive research and development programs over the next 50 year period can result in solar energy relieving 30% of the natural gas demand and 10% of the fuel oil demand in the USA. Other systems currently under development, such as ocean thermal and artificial hydrodynamics, are described.

RESEARCH AND DEVELOPMENT

10575 (NSF/RA—77-0064) **Appropriate technology: a directory of activities and projects.** (Integrative Design Associates, Inc., Washington, D.C. (USA)). 1977. 71p. GPO.

The directory is a product of a study by the National Science Foundation as part of an ongoing effort to explore opportunities for future research programs, a growing number of innovators in the field had been developing technologies that incorporated a concern

for maintenance of the ecological balance by increasing the use of renewable resources, extending recycling and diminishing waste, and fostering the resource independence of local areas. These technologies had begun to be called appropriate technologies. But before it could be determined whether RANN could make a contribution to the development of this new approach, it was necessary to survey the field to learn from these individuals and groups about the scope of their activities, the legal and technical problems they are facing in moving from idea to application, and their recommendations for Federal activity in support of appropriate technology. This directory is, in part, a compilation of the descriptions of activities of the survey respondents.

10576 Appropriate technology and agriculture in the United States. Washington, DC; Integrative Design Associates, Inc. (1977). 29p. (NSF/RA—77-0066). GPO.

This paper was prepared as a background paper for a broader paper, Appropriate Technology in the United States—An Exploratory Study (NSF/RA—770064, also available, GPO). Its purpose was to survey those in the United States currently active in the field of appropriate technology, describe their efforts, explore factors inhibiting the development and application of their innovations, report on their recommendations, and assess the policy implications of appropriate technology in relation to an environmentally and resource-constrained economy. It compiles and analyzes the major ideas of 40 of the 294 respondents in the initial survey. (MCW)

10577 Energy R and D and international cooperation. Hashimoto, H. *Chinetsu Gijutsu;* No. 4, 3-10(Oct 1976). (In Japanese).

The necessity of international cooperation in energy R D is discussed. The present state of international cooperation, its significance and future is described. The International Energy Agency is presently active in the fields of solar, geothermal, hydrogen, coal and nuclear energy and in energy systems analysis. The US, France and West Germany are working directly with Japan. In international efforts it is important to assess the technical level, finances and politics of each party involved and develop a level of cooperation which can strike a balance with individual development. To ensure effective future cooperation it is necessary to budget adequate funds, to train scholars, to stimulate cooperation between private companies and to interact with developing nations.

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 9760, 10259, 10271

10578 (CONF-7605161—, pp 51-57) **Future role of nuclear energy.** Holy, Z.J.; Kemeny, L.G. 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

World energy supply problems over the next fifty years are discussed against a background of dwindling fossil-fuel reserves. Three distinct phases in the satisfaction of world energy needs are outlined, with particular reference to the role of nuclear energy. The main characteristics of the first phase are the problems of fossil-fuel supplies, with only a limited contribution from nuclear energy for electricity generation. In the second phase, it is envisaged that nuclear power will increase its share substantially, and will begin to supply process heat for improved utilization of fossil fuels and other industrial processes. The third phase anticipates the large-scale introduction of fast breeder reactors for electricity generation, with high-temperature gas-cooled reactors supplying heat for the production of hydrogen as an all-purpose fuel. The Australian energy situation is briefly discussed in relation to coal, oil, and uranium reserves.

10579 Nuclear power proliferation: problems of international control. Johnson, B. (International Inst. for Environment and Development, London). *Energy Policy;* **5**: No. 3, 179-194(Sep 1977).

Some of the present limitations of international institutions in achieving control and management of nuclear power are reviewed and appraised. The nuclear industry is experiencing a multiple crisis in which economic, technical, and ethical aspects are blended. Nuclear hardware costs have increased faster than inflation in the last five years, largely as a result of delays in program completion arising from reactor and fuel-cycle safety problems. Meanwhile, there is a widespread and growing doubt, partly as a result of this cost escalation, as to whether capital will be available to finance the electricity-generating levels projected by the industry and by governments for the 1990s. The nuclear industry is now in trouble at every stage of the fuel cycle. The industry's difficulties have also revealed a lack of overall--but particularly nuclear--energy strategy at either national or international levels, and a lack of will to create regulations and institutional machinery at either of these levels that could reassure the concerned public and the energy industries.

10580 Nuclear siting using decision analysis. Keeney, R.L.; Nair, K. (Woodward-Clyde Consultants, San Francisco). *Energy Policy;* **5**: No. 3, 223-231(Sep 1977).

Suitable additional future sites are identified for nuclear-power-generating facilities of 3000-MW capacity in Washington and parts of Oregon and Idaho. A series of screening models was used to identify nine specific sites for evaluation by decision analysis. Six major objectives concerning health and safety, environmental effects, socioeconomic impacts, and financial considerations were formally employed over the six attributes to measure the degree to which the objectives were met. Possible impacts at each site were assessed for each attribute. Evaluation and sensitivity analyses led to the recommendation that site-specific studies should be conducted at three sites to select one for proceeding to the formal licensing process. Preferential ranking data are summarized in tables. 14 references/footnotes.

10581 Urgency of the fast breeder: to delay or not. Cutts, B. (United Kingdom Atomic Energy Authority, Warrington, Eng.). *Energy Policy;* **5**: No. 3, 245-250(Sep 1977).

The author takes issue with an earlier article in which Leslie Grainger questioned the value of pursuing fast breeder technology on the grounds that its low rate of plutonium production will preclude any significant impact on the need for uranium. Burton Cutts points out that uranium-fueled reactor and North Sea oil are only temporary energy sources, while breeder reactors will provide a permanent energy supply. The United Kingdom's breeder program is reviewed, and the author criticizes Grainger for oversimplifying his analyses and making unrealistic assumptions about projected economic growth and generating capacity. Cutts objects to Grainger's selective use of systems analysis and his failure to project a significant role for the breeder reactor. Grainger responds by restating his position in favor of properly applied nuclear power as a complement to coal and advocating full public debate of the issues. (DCK)

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 10047, 10559, 10566, 10656

10582 (CONF-770632—) **Proceedings of the Energy Research and Development Administration conference on cogeneration and integrated energy/utility systems.** (National Consumer Research Inst., Washington, D.C. (USA)). 1977. Contract W-31-109-ENG-38-31-109-38-3972. 209p. Dep. NTIS, PC A10/MF A01.

From Conference on cogeneration and integral energy/utility systems; Washington, District of Columbia, USA (3 Jun 1977).

Cogeneration or Integrated Energy/Utility Systems have established their place in contributing energy supply in major cities throughout the United States. Cogeneration has been primarily associated with industrial processes, while integrated energy systems have been primarily associated with residential and commercial applications or with district heating of large metropolitan areas. The conference was conceived to bring the two ideas together as much as technically and economically possible. An attempt was made to broaden the scope and integrate the two concepts establishing a very workable basis for the utilization of both in the performance of providing utility services to industrial applications and population centers. The resurgence of cogeneration evolves through the efforts to maximize the use of resources in the United States today. This forum, brought together some of the most prominent individuals associated with the concepts of cogeneration, community energy systems, and integrated utility systems. (MCW)

10583 (COO—2947-2) **System analysis design and proof-of-concept experiment of a total energy system. Quarterly progress report, 16 August 1976—15 November 1976.** Lehrfeld, D. (Philips Labs., Briarcliff Manor, N.Y. (USA)). Dec 1976. Contract EY-76-C-02-2947. 52p. Dep. NTIS, PC A04/MF A01.

The conceptual design of a Stirling System was completed (Task I: for the three diverse sites selected for this study) a residential complex located in Jersey City, NJ; an office building located in Anchorage, Alaska; and a hospital located in Fairfield, California. Electrical and thermal demand profiles for the sites were analyzed for heating, cooling, electricity, excess heat rejection, supplementary heating and cooling, and storage. Task II, Evaluation of Basic Designs was initiated. (MCW)

10584 (COO/4210—1(Summ.)) **Grid-Connected Integrated Community Energy System. Executive Summary. Final report. Phase I, February 1, 1977—May 31, 1977.** (Minnesota Univ., Minneapolis (USA)). Jun 1977. Contract EC-77-C-02-4210. 122p. Dep. NTIS, PC A06/MF A01.

A brief review of the University of Minnesota's program for a Grid-Connected Integrated Community Energy System (ICES) is given. The Community energy system focuses on modifications to the central heating plant on campus, wherein the capability of

generating additional steam and by-product electricity will be established by acquiring a retired generating plant. A second area of importance is the adding on of Community gas/oil committed loads to the coal-fired system. The third area of importance in the proposed total ICES involves the installation of a pyrolysis system for the safe disposal of infections and hazardous waste whereby a low Btu gas will be generated. This will then be utilized in the plant as a supplement to its primary fuel requirements. The fourth area being investigated is the conversion of part of the steam distribution system to a variable flow and variable-temperature hot water system. Economics indicate that hot water will most likely be the distribution system for co-generation plants in the future. (MCW)

10585 (COO/4212—1/1) **Trenton ICES. Volume I. Phase I, final report.** (City of Trenton, N.J. (USA). Dept. of Planning and Development). 14 Jul 1977. Contract EC-77-C-02-4212. 68p. Dep. NTIS, PC A04/MF A01.

Phase I Preliminary Design and Evaluation for a Grid Connected Thermally Controlled Integrated Community Energy System (ICES) for Trenton, New Jersey has been carried out. The findings of the study are that: it is technically feasible, utilizing commercially available hardware; it is economically competitive with conventional alternatives for heating and cooling buildings; it will produce an overall reduction in fuel consumed of 32 to 43% when compared with conventional alternatives for heating and cooling buildings; it will consume 4 to 9% more oil than will conventional alternatives for heating and cooling buildings; it should be owned and operated by Public Service Electric and Gas Co. (PSE and G); and it can provide thermal energy 21 months after the start of Phase II and electrical energy 32 months after the start of Phase II. This study is site-specific and of a small-size project. Its installation will not alter the planned PSE and G capacity expansion program. The economic evaluation results of the report cannot be extrapolated for numerous co-generation installations that would affect the PSE and G planned capacity-expansion program.

10586 (COO/4214—1/1) **Grid-connected ICES preliminary feasibility analysis and evaluation. Final report. Volume I. Executive summary.** (de Laureal Engineers, Inc., New Orleans, La. (USA)). 30 Jun 1977. Contract EC-77-C-02-4214. 56p. Dep. NTIS, PC A04/MF A01.

A group of hospitals, clinics, research facilities, and medical education facilities, known as the HEAL Complex, was chosen as the site (in New Orleans) for the demonstration of a Grid-Connected Integrated Community Energy System (ICES). The contract work included a preliminary energy supply/demand assessment of the Demonstration Community, a preliminary feasibility analysis and conceptual design of a candidate Demonstration System, preliminary assessment of institutional factors, preparation of a detailed work management plan for subsequent phases of the demonstration program, firming-up of commitments from participating parties, and reporting thereon. This Phase I study has indicated that a central ICES plant producing steam, chilled water, and by-product electricity to serve the HEAL Complex is technically and economically feasible to the extent that Phase II, Detailed Feasibility and Preliminary Design, should be implemented. (MCW)

10587 (ORNL/TM—5786) **Preliminary investigations of the thermal energy grid concept.** Olszewski, M. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 107p. Dep. NTIS, PC A06/MF A01.

This study examines, in a preliminary manner, the feasibility of the thermal grid concept. This concept essentially envisions the supply of heat to a long-distance transmission line from a dual-purpose nuclear or coal-fired power plant. The transmission line delivers heat to a subregion distribution network which delivers it to the consumer. District chilled water supply is also considered, using heat from the grid to power steam-turbine-driven water chillers. Candidate technologies for generation, transmission, and distribution of thermal energy are identified and assessed. Potential applications, including both industrial use and residential space conditioning and hot water supply, are evaluated. Results indicate that high-temperature hot-water transmission lines are favored for longer distances, while steam lines may be acceptable for shorter distances. It is also evident that thermal grid heat is more economically competitive for new applications, as opposed to retrofit situations, in the residential-commercial sector. The two applications are about equally feasible in the industrial sector. The results further indicate that thermal grid heat is most competitive in areas of high-heat-load density and expensive fuel costs. It appears that the thermal grid service area should include the industrial sector as a base load. The multifamily residential-commercial sector space and water heating loads can be added to the service area to maximize utilization of the transmission line and maintain low transmission costs. Supply of chilled water to the multifamily residential-commercial sector can also be included for new applications to increase the transmission line use factor. The thermal grid concept appears to be economically and technically feasible, when compared to oil and electric systems in the multifamily residential-commercial sector and coal- or oil-fired systems in the industrial sector, and should be explored in greater detail.

CONSERVATION

REFER ALSO TO CITATION(S) 10559, 10561, 10570, 10571, 10591, 10608, 10618, 10619, 10625, 10630, 10631, 10632, 10635, 10638, 10639, 10640, 10641, 10642, 10643, 10644, 10646, 10856

10588 (CONF-760895—, pp 323-335) **Intercity passenger modal shifts as an energy conservation option.** Bowles, R.L. (Federal Energy Administration, Washington, DC). May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

This report deals with the study of various policies that affect energy savings in intercity passenger movement. Presently, 99 percent of all fuel consumed in intercity passenger travel is by auto and air modes. FEA is concerned with studying the regulatory, modernization, operational efficiencies and intermodal shifts that have potential for energy savings. This paper deals with the strategies for mode shifts. Two corridors—Northeast and California—are studied and results documented. Twenty-two scenarios (eighteen individual strategies and four combinations) were modeled for the 1982 time frame. Individual strategies include: adjustments of air fares through regulatory or tax actions; rail and bus fare reductions; auto cost increases; rail and bus block time improvements; reduced auto availability; and reduced air service frequency. Results of various strategies studied are well documented.

10589 (SAN/1178—1) **California residential energy standards: problems and recommendations relating to implementation, enforcement, and design.** (California State Dept. of Housing and Community Development, Sacramento (USA)). Aug 1977. Contract EY-76-C-03-1178. 373p. Dep. NTIS, PC A16/MF A01.

Documents relevant to the development and implementation of the California energy insulation standards for new residential buildings were evaluated and a survey was conducted to determine problems encountered in the implementation, enforcement, and design aspects of the standards. The impact of the standards on enforcement agencies, designers, builders and developers, manufacturers and suppliers, consumers, and the building process in general is summarized. The impact on construction costs and energy savings varies considerably because of the wide variation in prior insulation practices and climatic conditions in California. The report concludes with a series of recommendations covering all levels of government and the building process. (MCW)

10590 **Residential energy conservation: analysis of U.S. Federal programmes.** Hirst, E.; Carney, J. (Oak Ridge National Lab., TN). *Energy Policy;* **5**: No. 3, 211-222(Sep 1977).

The authors examine three residential energy conservation programs under study and development by the U.S. government and conclude that they offer both energy savings for the nation and money savings for individual households. These programs include setting appliance-efficiency targets, developing new thermal standards for housing, retrofitting existing houses to improve thermal performance, and a stronger energy conservation program. The programs are compared using a model developed for the Federal Energy Administration and ERDA, which projects consumption up to the year 2000. The adoption of these programs, while seemingly inevitable as fuel supplies dwindle and prices rise, will require vigorous programs of consumer education and financial incentives. 4 figures, 7 tables, 17 references/footnotes.

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 9699, 10560, 10598, 10600, 10607, 10634, 10651

10591 (CONF-771003—P1) **Improved conversion efficiency workshop. Volume I. Working papers.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Conservation Research and Technology). 1977. 35p. Dep. NTIS, PC A03/MF A01.

From CONRT'S improved conversion efficiency workshop; Pipestem, West Virginia, USA (16 Oct 1977).

This pre-Workshop brief deals with the energy situation in the United States and the ERDA Division of Conservation Research and Technology activities. Chapter 1 provides an overview of the national energy situation and the National Energy Plan for achieving a transition from scarce oil and gas to more-abundant, renewable sources of energy. Chapter 2 describes CONRT's role in the transi-

tion and the technology options for improving energy conversion efficiency in the four energy-using sectors. Chapter 3 provides some essential information on the discussion topics: the projects constituting CONRT's Improved Conversion Efficiency Subprogram for fiscal year 1978; CONRT's project appraisal methodology; and CONRT's annual planning cycle and the role of the workshop series in the planning process. (MCW)

10592 (CONF-7605161—, pp 63-67) **Forecasting and production technology: an outlook on manufacturing systems.** Arndt, G. (Univ. of Auckland, New Zealand). 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

In the overall framework of futurology an outline is presented of some recent world model studies and the techniques available for technology forecasting and assessment, leading up to the Delphi-type prognosis of the future of production technology performed by CIRP. The most important feature of this prognosis is the coming of the computer-integrated "automatic factory", i.e. the realization of sophisticated manufacturing systems complete with computer-controlled, on-line automation, and optimization of the machining and part-handling processes. Such "factories" are estimated to be in wide use by 1990. The development and implications of such flexible manufacturing systems and their impact on society are considered. Their economic, social, and environmental effects should be beneficial, but the role of the factory worker will have to be redefined. Some first examples of "automatic factories" already in operation are described. Before even contemplating such systems in Australia, computer-aided manufacturing needs to be much more widely accepted here. In fact, local manufacturing lends itself well to the widespread application of numerical- and computer-control. 41 refs.

10593 (LBL—6831) **Distributed technologies in California's energy future. Volume I.** Christensen, M.; Craig, P.; McGuire, C.B.; Simmons, M. (eds.). (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; California Univ., Berkeley (USA); California Univ., Davis (USA); California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1977. Contract W-7405-ENG-48. 248p. Dep. NTIS, PC A11/MF A01.

This interim report contains eight of the eighteen chapters included in the complete report. In Chapter I, pertinent data, facts, and observations are made following an initial summary. Chapter II is an introduction, citing especially the writings of Amory Lovins. The criteria used in defining distributed systems, suggested by Lovins, are that the technologies be renewable, environmentally benign, local, subject to graceful failure, foolproof, flexible, comprehensible, and matched in energy quality. The following chapters are: The Energy Predicament; The California Setting; Energy Resources for California's Future; Alternative Energy Futures for California; Issues and Problems; and Directions for Future Work. Six appendices deal with residential heating loads and air conditioning, allocations, co-generation, population projections, and the California wind energy resource. (MCW)

10594 (ORAU/IEA—76-7) **U.S. energy and economic growth, 1975—2010.** Allen, E.L.; Cooper, C.L.; Edmonds, F.C.; Edmonds, J.A.; Reister, D.B.; Weinberg, A.M.; Whittle, C.E.; Zelby, L.W. (Institute for Energy Analysis, Oak Ridge, Tenn. (USA)). Sep 1976. Contract EY-76-C-05-0033. 92p. Dep. NTIS, PC A05/MF A01.

This study projects economic growth (GNP) and energy demand for the U.S. to the year 2010. The main finding is that both GNP and total energy demand are likely to grow significantly more slowly than has been assumed in most analyses of energy policy. Projections of energy, GNP, and electricity (total and per capita) are summarized, with electricity demand expected to grow more rapidly than total energy demand. Two scenarios designated "high" and "low" were developed in this study. However, even the "high" scenario, 126 quads (q; 1 q equals 10^{15} Btu) in 2000, is much lower than most previous estimates. It is felt that this raises serious questions about fundamental energy and energy R and D policies which, generally, have been based on perceptions of more lavish energy futures. Although the aggregate demands and GNP are projected to increase rather modestly, the energy demands per capita and GNP per capita increase at rates comparable to or even higher than historic rates. The authors believe that the projections developed in this study represent a logical culmination of many trends toward lower growth. These trends have not yet been factored into the older energy projections upon which so much energy policy is based. 136 references.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 9679, 9680, 9681, 9682, 10568, 10569, 10579, 10611, 10619, 10635

10595 (FEA/F—77/305) **Federal Energy Administration annual report, 1976/1977.** (Federal Energy Administration, Washington, D.C. (USA)). 1977. 248p. Dep. NTIS, PC A11/MF A01.

This Third Annual Report recounts some of the accomplishments and the principal purposes of the Federal Energy Administration, June 1976 through May 1977. Methods for dealing with complex energy situations and plans to deal with existing energy conditions are detailed in Chapter One. Forecasting the energy future is dealt with in Chapter Two, while Chapters Three and Four contain additional information on financial aspects and information-gathering activities of FEA. (MCW)

10596 (HI—2633/3-P) **Politics of the energy transition: policy trade-offs in an inflationary economy.** Smernoff, B.J. (Hudson Inst., Inc., Croton-on-Hudson, N.Y. (USA)). Sep 1977. 57p. Institute, Inc., New York.

This paper examines the nature of the U.S. energy problem. The emphasis is on policy trade-offs which must be made in an inflationary economic environment and a contentious political climate, at least during the foreseeable future. The basic elements of the energy problem are characterized as follows: a gradual transition away from conventional oil; implement a slower energy-growth; utilize energy efficiently and produce adequate supplies of domestic energy by using traditional economic institutions; practice conservation and develop coal; shape national energy policy with informed awareness; alleviate conflicting images of the desirable and/or feasible American energy future; practice prudent energy planning that requires the informed consideration of many types of risks. The paper is organized into an introduction, followed by seven sections corresponding to these basic points and their corollaries. There is no attempt to make firm recommendations about the detailed shape of national energy policy. The primary purpose of this paper is to explore aspects of economic and political reality that confront energy planners, legislators, and the American public with hard choices. (MCW)

10597 (IPC—76-41) **Government overregulation and its effects on industry.** Weidenbaum, M.L. (Washington Univ., St. Louis, Mo. (USA). Center for the Study of American Business). 1976. vp. (CONF-7604139—4). Petroleum Refiners Association, Washington, DC.

From 1. international petrochemical conference; San Antonio, Texas, USA (4 Apr 1976).

A massive expansion of government controls over private industry is underway in the United States, the author begins. Government officials are exercising an even larger role in what traditionally has been internal business decision making. The traditional theory of government regulation of business is based on the model of the Interstate Commerce Commission. The new regulations passed by Congress recently follow a new pattern, more restrictions. The newer type of regulatory activity is far more likely to utilize the resources of various industries, or to ignore their needs, in order to further the specific objectives of the agency. These new regulations cost, and these costs are passed on to the customer. It costs to establish the new regulatory agencies and it costs industry to process the additional paperwork. A hidden cost is a reduced rate of technological innovation due to the required process. The proliferation of government controls has led to conflicts. Specific examples are cited of regulations required by the various governmental agencies on specific industries. (MCW)

10598 (NP—22609) **Allegheny County's response to the President's Energy Policy and Planning Office.** (County of Allegheny, Pittsburgh, Pa. (USA). Board of County Commissioners). 1977. 31p. .

The citizens of Allegheny County, Pennsylvania submitted a list of recommendations to President Carter based on their experiences during the winter of 1977, the worst winter on record. With the closing of factories and schools, losses in production, sales, and earnings resulted. Recommendations are included from various county departments on immediate, short-range, and long-range measures. (MCW)

10599 **Energy planning and policy: the political economy of Project Independence.** Tietenberg, T.H. Lexington, MA; D.C. Heath and Company (1976). 182p. .

This book documents what went on within the government during the first two years of Project Independence and extracts from this discussion the forces that affected the responsiveness of the policy process. It characterizes the historical precedent, describes the response taken to quantify the consequences of alternative actions, discusses the integration of these results with political considerations to form the energy packages that emerged, and explains the reasons for the metamorphosis of each of these packages as they proceeded through the policy process. The final section provides an evaluation of the substance and process of energy policy. In Chapter 9 a decision theory model, which characterizes possible future states of the world and quantifies the relationships among current policies and future outcomes, is used to describe the desirability of a range of

policy packages. The final chapter suggests what can be learned from this case study about the responsiveness of the policy process. The analysis is restricted to the historical period prior to October 31, 1975. (MCW)

FOSSIL FUELS

10600 (FEA/S—77-359) **Other storage reserves report (Public Law 94-163, Section 158).** (Federal Energy Administration, Washington, D.C. (USA)). 16 Aug 1977. 70p. Dep. NTIS, PC A04/MF A01.

This report provides recommendations to the Congress concerning the Other Storage Reserves, in accordance with the requirements of the EPCA. The following conclusions are presented: (1) there is a need for utilities to maintain adequate levels of fuel reserves to avoid interruptions in electric power generation; (2) there is not a need at this time for Federal coal reserves to meet long-term demands or emergency requirements; (3) there is not a need at this time for remote crude oil and natural gas reserves.

10601 (NP—22653) **Selected research projects leading to the development of Utah coal, tar sands, and oil shale. Phase I research for the 1975—1976 period.** (Utah Univ., Salt Lake City (USA)). Mar 1977. vp. of Utah, Salt Lake City.

This Phase I report is an important initial step in the long-range planning process necessary to assure the orderly and economic development of Utah's fossil-fuel resources. Basic purposes of this program are: to provide information pertinent to the development of energy resources; to improve the technology and economics of resource recovery; to identify the industrial chemical potential of resources; to explore other commercial uses of resources. To achieve these objectives, five research projects were initiated: investigation of tar sands as a potential source of asphalts and petrochemicals; solution mining of coal; feasibility of solvent extraction of bitumen from oil shale; study of the combustion process in oil shale beds; and study of the chemical values of oil shale recoverable by rapid pyrolysis. The following key conclusions were determined: asphalt from the Utah tar sands bitumen is of high quality and appears to be competitive; the unexpectedly high permeability determined for Utah coals enhances the feasibility of using the solution-mining process; Utah oil shales have been found to be high in solvent-soluble compounds, thus increasing their potential commercial value; concepts important to the rapid pyrolysis of oil shale have been demonstrated as valid; and a significant data base has been produced.

COAL

REFER ALSO TO CITATION(S) 9594, 9595, 9643, 9644, 9645, 9655, 9656, 9675, 9677, 9678, 9679, 9680, 9682, 10053, 10054, 10055

PETROLEUM

REFER ALSO TO CITATION(S) 10634

10602 **High OPEC oil prices ultimately beneficial to all.** Attiga, A. (Organization of Arab Petroleum Exporting Countries). *Energy User News;* **2**: No. 45, 26-27(14 Nov 1977).

Excerpted from an address, "The impact of energy transition on the oil exporting countries," given at the fourth international energy conference in Boulder, Colo.

Past energy transitions involved increased exploration of fossil fuels to provide a higher standard of living, while the present transition is involved with the shift from nonrenewable to renewable energy sources. Oil and gas, needed to supply our energy needs during the transition, will last longer with adequate pricing. Higher prices can stimulate exploration as well as reduce demand. A Delphi poll by the World Energy Conference Conservation Commission indicates estimates of oil reserves are three times larger than proven reserves and justifies prices high enough to stimulate investment in exploration. Continued low prices will deter the development of oil shales, coal, biomass, and other alternative sources. Policies to conserve and properly price oil are needed for both the consuming and producing countries. The oil-importing countries should share this burden with the exporting countries by developing energy and economic growth policies that will diversify energy sources and assume a more rational approach to consumption. (DCK)

NATURAL GAS

REFER ALSO TO CITATION(S) 9696, 9697, 9699, 9712, 10603

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 9856, 10669

10603 (TID—27747) **Evaluation of the use of hydrogen as a supplement to natural gas.** (Ad Hoc Committee on the Use of Hydrogen for Natural Gas Supplementation (USA)). Jun 1977. 71p. Dep. NTIS, PC A04/MF A01.

The potential for mid-term (1985-2000) commercial application of the use of hydrogen for blending into the present natural gas delivery system as an energy supplement was studied. Successful development of advanced electrolyzer technology and availability of low-cost "off-peak" and "spinning reserve" electric-generating capacity are basic to this concept. Because no source was found that would make such a concept economically viable in the near future, the Committee determined that a major, Federally funded R, D, and D program aimed at proving the technical feasibility is not justified within the next five years. In the considered opinion of the Committee, even a completely successful R, D, and D program within five years would not spur mid-term commercialization to: produce sufficient hydrogen to significantly alleviate the natural gas shortage on a national basis; produce hydrogen at a cost competitive with other supplemental gaseous fuels if present price projections hold true; provide the electric power industry with incentives to devote available generating capacity to this end in competition with various storage concepts, operating alternatives, and end uses under development. The Committee found no overriding environmental, safety, legal, code, or regulatory considerations that would preclude the hydrogen-natural gas supplementation concept. Fostering of long-term research activities for hydrogen production using water electrolysis is recommended in connection with other prospective end uses. A periodic review of R and D efforts that relate to commercialization of natural gas supplementation with hydrogen is also recommended.

ELECTRIC POWER

REFER ALSO TO CITATION(S) 10560, 10582, 10612

10604 (FEA/G—77/360) **Impacts of the western drought on the regional electricity situation.** (Federal Power Commission, Washington, D.C. (USA); Federal Energy Administration, Washington, D.C. (USA)). 30 Sep 1977. 152p. Dep. NTIS, PC A08/MF A01.

This report examines the projected electrical demand and supply situation in the West, with particular emphasis on the Pacific Northwest situation during the winter of 1977. While the projected shortage of energy is small, continued lack of precipitation and failure to pursue conservation measures could result in a more critical situation. An interim report was published on March 31, 1977, placing greater emphasis on the California situation since California is a summer-peaking state. The present report updates that evaluation and presents new information based on the Pacific Northwest's winter electricity outlook.

10605 **Electricity economics: essays and case studies.** Turvey, R.; Anderson, D. Baltimore; Johns Hopkins University Press (1977). 381p. .

These studies deal with the economic theory and practice of pricing and investment in electricity supply. There are seven chapters on applications, five on principles, and the final four clear up some deficiencies in existing theory. The chapters following an introductory chapter are Economics, Finance, and Equity in Tariff Policy; Electricity Tariffs in Thailand; Electricity Tariffs in Tunisia; Electricity Tariffs in Sudan; An American Tariff Structure; Rural Electrification in Developing Countries; Electricity Development in Turkey: A Case Study Using Linear Programming; How to Study Tariffs; The Rate of Return on Projects—and Relations between Pricing and Investments; The Willingness-to-Pay Criterion; a Layman's Guide to Shadow Pricing; Investment Planning Models; Optimal Electricity Pricing Under Uncertainty; Cost Structure in Hydro and Hydro-Thermal Systems; Tariff Structures with Simple Metering; and A Note on Optimal Pricing and Indivisibilities. (MCW)

ELECTRIC POWER GENERATION

10606 (EPRI-NP—493) **Assessment of methods for implementing availability engineering in electrical power plants. Final report.** Cleveland, E.B.; Jarrett, A.A.; Morrison, C.B. (Holmes and Narver, Inc., Anaheim, Calif. (USA)). May 1977. 92p. Dep. NTIS, PC A05/MF A01.

This technology planning study was prepared to define and assess availability engineering, its practice, its possible rewards, and its limitations as a means of increasing productivity in existing and new electric power plants. Availability engineering is defined as the systematic engineering approach used to set and achieve a numerical availability goal at minimum cost. It can be applied to major components, to plant systems, to modifications of operating plants, and to new plants. The methodology of availability engineering can be applied by engineers charged with improving power plant perfor-

mance. It is an extension of ongoing engineering activities which introduces the specification and assessment of outage frequency and duration as a way of controlling availability. To assist in the implementation of availability engineering the following support activities are recommended: (1) A well coordinated industry-wide education program should be conducted to acquaint management and engineers with availability engineering methods and their efficient application. (2) The feedback of past experience should be greatly improved in depth of coverage, ease of reporting, timeliness of reports and ready access by all users. Also a consistent set of definitions is needed to avoid misunderstanding in the reporting. (3) Several standards or guides should be prepared covering the subjects of: setting availability goas, reliability and maintainability requirements for procurement specifications, availability of influences external to units. (4) Demonstrations should be sponsored which show the application of the methods to some current problems. An annotated bibliography of 41 references is included.

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 10589, 10592, 10613, 10618, 10628, 10629, 10630, 10631, 10632, 10633, 10636, 10637, 10638, 10640, 10641, 10643, 10645, 10646, 10669

10607 (CONF-760895—, pp 1-17) **Perspectives on the U.S. energy scene.** Dupree, W.G. Jr. (Bureau of Mines, Washington, DC). May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

This paper provides the historical perspectives of energy consumption within the USA. Gross energy consumption by source is also discussed. It is concluded that GNP is directly related to the energy consumption patterns within the U.S. The report also deals with the energy mix during the 1947-75 period; the use of coal, of course,declined while use of petroleum increased. Projections are made for the energy use by source through the year 2000. The author predicts that by year 1985 nuclear power will have a significant share of the energy market and also concludes that the three major energy sources in order will be petroleum, nuclear, and coal.

10608 (CONF-760895—, pp 39-49) **Energy analysis for urban transportation systems: a preliminary assessment.** Hartgen, D.T. May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

The capability of conventional UTPS planning procedures to deal with energy issues are discussed and evaluated in this paper. Central energy-related issues for planning are identified as (1) reevaluation of long-range plans; (2) modal alternatives; and (3) investment needs and funding flow. The conventional UTPS process is found to be capable of dealing quite well with certain energy policies such as speed reductions and increased vehicle efficiency, but generally is a weaker tool for addressing other policies such as rationing, Sunday driving bans, and urban activity redistributions. The sensitivity analysis capability of UTPS appears stronger than its capability to predict actual impacts. Specific information on gasoline price elasticity of travel by trip purpose, as well as trip priorities would greatly increase the predictive power of the system.

UNCONVENTIONAL SOURCES AND POWER GENERATION

10609 (AED-CONF—77-002-007) **Possibilities of developing new non-nuclear and non-fossil energy sources.** Lehner, G. (Stuttgart Univ. (TH) (Germany, F.R.)). 1977. 15p. (In German). (CONF-770236—2). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 2. international fair and congress on techniques in environmental protection; Duesseldorf, F.R. Germany (8 Feb 1977).

As possible nonnuclear and nonfossil new energy sources one can discuss three essentially different options—tidal energy, geothermal energy, and solar energy. The word solar energy is used here in a broad sense including the direct use of solar radiation and the indirect use of secondary energies derived from solar radiation. A discussion of the natural energy resources of the earth leads to an evaluation of the future possibilities for the different options. The potential of tidal energy is very small. Geothermal energy has a much larger potential, but only if one considers the heat stored in "hot dry rocks." The technology for its use is not yet available. It may meet economic and environmental difficulties. Thus, the future importance of geothermal energy is not clear now. Solar energy finally has an extremely large potential. Technologies for several methods of its more or less direct use are available. The main problems are economic ones. In the long run, solar energy should be able to contribute significantly to the solution of the energy problem if the economic problems can be solved; in the short run, an appreciable contribution is, however, not to be expected.

10610 (AED-CONF—77-053-001) **Survey lecture on renewable energy sources.** Meliss, M. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Programmgruppe Systemforschung und Technologische Entwicklung). 1977. 19p. (In German). (CONF-770377—1). Dep. NTIS (US Sales Only), PC A03/MF A01.

From 134. meeting of the Haus der Technik e.V. on nonconventional energy carriers; Essen, F.R. Germany (21 Mar 1977).

The essay deals with utilizable regenerative energy sources: geothermal energy, tidal energy, solar energy, running water energy, and wind energy. Tests for the development of these sources have been carried out, but only one of them has a considerable share in meeting the energy demand--that gained from running water. The others are only of regional importance (geothermal energy, tidal energy) or have lost the importance they once had (wind energy, biochemical energy in the form of wood). The latest discussions about the restrictions on fossil and nuclear energy sources and the environmental effects of the technologies necessary for their utilization have increased the interest in the "inexhaustible" energy sources. This is why the author outlines the possible importance of renewable energy sources.

SOLAR

REFER ALSO TO CITATION(S) 9862

10611 (TID—27773) **Solar access and land use: state of the law, 1977.** Miller, A.S.; Hayes, G.B.; Thompson, G.P. (Environmental Law Inst., Washington, D.C. (USA)). 1977. Contract EX-76-C-01-2528. 34p. Dep. NTIS, PC A03/MF A01.

It is generally accepted that property owners in the United States have no right to receive solar energy that would reach their land only after slanting across property owned by others. There is a right, of course, to sunlight falling perpendicularly on your land, with the trifling exception of shadows cast by aircraft. This chapter on land use is a concise summary of the state of the law in the field but does not present recommended solutions or planning and legislative tools. It is a chapter from a larger study, Legal Barriers to Solar Heating and Cooling of Buildings (available NTIS). It is tentatively concluded that a combination of approaches will probably work best. Fortunately, the authors say, from a legal standpoint, the owners of structures in the existing built communities are interested in solar heating and cooling. Direct Federal role is presently nonexistent, and it should be up to states and localities to choose and enact model laws that meet the special needs of their geographic regions. Some actions and procedures are listed. A compilation of 169 notes and references is provided. (MCW)

10612 **Solar energy and U.S. public utilities: the impact on rate structure and utilization.** Dickson, C.; Eichen, M.; Feldman, S. (Clark Univ., Worcester, MA). *Energy Policy;* **5**: No. 3, 195-210(Sep 1977).

The possible effects of widespread adoption of solar power are examined in the context of utility rate structures. Solar space heating and cooling systems normally require some form of backup to take account of protracted periods of cloudy weather. With relatively low utilization, capital costs are likely to be the most crucial aspect in choosing such backup systems, and the tendency will be to choose systems running on electricity or natural gas. Widespread adoption of solar power could have a profound effect on utility demand patterns. The cost-effectiveness of solar power can be crucially dependent on the rate structure chosen and on whether the system is considered from the point of view of the customer or the utility. In the appendix the authors provide details of current research and development on solar space heating in the United States. 1 figure, 7 tables, 18 references/footnotes.

GEOTHERMAL

REFER ALSO TO CITATION(S) 10047

OTHER

REFER ALSO TO CITATION(S) 10566

10613 (CONF-7605161—, pp 8p, Paper 322/4) **Land use aspects of energy availability.** Anderson, M.C.; Fleming, P.M. 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

The constraints and conflicts of various forms of land use are discussed in the context of the present world pattern of land and

energy use. It is concluded that, within the simple constraints of climate, terrain and soils, Australia has but a limited area of uncommitted high productivity land. The uncommitted areas are about 25 x 10^6 ha of arable land and 29 x 10^6 ha of potential forest. Uncommitted water resources may allow development of a further 3 x 10^6 ha of intensive irrigated agriculture. An analysis of present agricultural production shows an energy output of 327 x 10^{15} J y^{-1} from 45 x 10^6 ha of arable land and an input of 130 x 10^{15} J y^{-1} of fossil fuel energy. The problems associated with the production of a significant proportion of liquid and gaseous fuels from biological sources is discussed and it appears that this is possble only with considerable changes in social and industrial patterns of energy consumption. 30 refs.

10614 Benefit—cost analysis of a nonmetropolitan prototype for solid-waste resource recovery. Hitzhusen, F. (Ohio State Univ., Columbus); Luttner, M. *Am. J. Agric. Econ.;* **59**: No. 4, 691-698(Nov 1977).

This study focuses on the recovery of energy and materials from solid waste at a coal-burning steam-electric plant located in a nonmetropolitan county in Northeast Ohio. The results of the analysis suggest that the resource recovery prototype involving a new solid-waste processing facility and modification of the existing steam-electric plant is an economically feasible investment. This conclusion is substantiated by sensitivity analysis of five key technical and economic parameters under four alternative benefit-cost and internal-rate-of-return criteria. 4 tables, 21 references.

ENERGY CONVERSION

REFER ALSO TO CITATION(S) 10752

MHD GENERATORS

REFER ALSO TO CITATION(S) 11402

DESIGN AND DEVELOPMENT

10615 (JPRS—69880, pp 11-33) **Experimental studies of the operation of an MHD generator with ash in the plasma.** Burenkov, D.K.; Dolinskii, Yu.L.; Zhdankin, V.N. 28 Sep 1977. Translation of Eksperimental'nyye issledovaniya raboty MGD generatora pri nalichii zoly v plazme.

In Translations on USSR science and technology: Physical Sciences and Technology No. 19.

The main goals in experimental research on the U-02 facility with simulated combustion of coal are: (1) to study methods of injecting and distributing solid fuel over the cross section of the combustion chamber to form an effective heat-resistant and arc-resistant slag lining on the walls of the combustion chamber and channel of the MHD generator, and to determine the temperature on the flame surface and its effect on the slag composition; (2) to determine the degree of trapping of slag in the combustion chamber and to test possible ways to remove slag and ash from the chamber; (3) to study the behavior of the slag film on the firewalls of the combustion chamber and MHD channel, to investigate the protective, aggressive and electrical properties of the film and its influence on the characteristics of the MHD generator; (4) to study the physicochemical interaction of compounds of ionizable additive with slag and ash, and methods of regenerating the additive when a mineral component is present in the fuel. Experimental procedures and results are described.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 10615

10616 (ANL/MHD—77-1) **Two-dimensional subsonic diffuser code.** Doss, E.; Geyer, H. (Argonne National Lab., Ill. (USA)). Jul 1977. Contract W-31-109-ENG-38. 91p. Dep. NTIS, PC A05/MF A01.

Results are presented of a study to produce a computer program to calculate the performance of subsonic diffusers, using a two-dimensional turbulent-flow model. The analytical model is capable of analyzing the performance of simple two-dimensional, plane-walled diffusers and the performance of three-dimensional diffusers up to and beyond the blockage limits for which previous analytical or experimental data are available.

DUCT ENGINEERING AND FLUID DYNAMICS

REFER ALSO TO CITATION(S) 10615

10617 (CONF-770530—1) **Subsonic MHD-diffuser performance with high blockage.** Doss, E.D. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. vp. Dep. NTIS, PC A02/MF A01.

From 16. engineering aspects of MHD symposium; Pittsburgh, Pennsylvania, USA (16 May 1977).

Diffuser performance with high blockages is analyzed by a two-dimensional turbulent-flow model. This model is used to analyze the performance of simple two-dimensional, plane-walled diffusers and also of three-dimensional diffusers up to and beyond the blockage limits for which previous analytical or experimental data are available. The effects of important design parameters on diffuser performance are investigated. The parameters considered are the blockage, divergence angle, Mach number, aspect ratio, and wall-to-free stream temperature ratio. The first two parameters affect the diffuser performance significantly; the other parameters influence performance only slightly. Results obtained from the subject model agree reasonably well with the available experimental data. The diffuser design of the U-25 facility is analyzed and the analysis predicts a pressure recovery of 0.49, which agrees very well with the measured experimental value of approximately 0.48, obtained from a small-scale model.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 9852

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 10500

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 10556, 10562, 10563, 10591, 10607

10618 (CONF-760895—) **Effects of energy constraints on transportation systems.** Mittal, R.K. (ed.). (Union Coll., Schenectady, N.Y. (USA)). May 1977. 418p. Dep. NTIS, PC A17/MF A01.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

A separate abstract was prepared for each of the twenty-one papers presented at the conference.

10619 (ORAU/IEA(M)—77-18) **Thermodynamics and energy policy.** Rotty, R.M.; VanArtsdalen, E.R. (Institute for Energy Analysis, Oak Ridge, Tenn. (USA)). Jul 1977. Contract EY-76-C-05-0033. 26p. Dep. NTIS, PC A03/MF A01.

Of all the fundamental physical considerations that enter into the determination of personal and collective energy policy, only one can be quantitatively addressed through thermodynamics: this is the minimal use of energy resources to achieve conservation of scarce energy supplies. Thermal efficiency (redefined in this work as effectiveness coefficient) has been widely used in evaluating energy exchanges, but this procedure gives no consideration to "quality" of energy being used. Thermodynamics indicates that different energy quantities also can have different energy quality, and efficient use of energy requires a matching of the energy quality supplied to that required for the given task. Thermodynamic efficiency as a "figure of merit" in evaluating energy exchanges has the advantage of considering energy quality. It does not, however, give information to assist in the trade-offs between energy resources and the other considerations that must be made in the formulation of an energy policy.

BUILDINGS

REFER ALSO TO CITATION(S) 10551, 10556

10620 (AED-Conf—77-053-002) **Ground as a heat source.** Neiss, J. (Technische Univ. Muenchen (Germany, F.R.)). 1977. 28p. (In German). (CONF-770377—3). Dep. NTIS (US Sales Only), PC A03/MF A01.

From 134. meeting of the Haus der Technik e.V. on nonconventional energy carriers; Essen, F.R. Germany (21 Mar 1977).

The thermophysical material parameters of the earth and measurements of the surface temperature curve and of the heat flow density through the earth's surface are discussed. It is shown that the heat flow density from the inner part of the earth is negligibly small compared to the heat flow density resulting from stored solar energy. The calculated results of the earth and solar temperatures in

extracting heat by heat pumps are given and explained in detail. It was found that only those soils having a high density and high water content are suitable for the ground heat pump.

10621 (AED-Conf—77-053-003) **Heat pumps for outer air.** Vielhaber, K. (Bosch (R.) G.m.b.H., Wernau (Germany, F.R.)). 1977. 16p. (In German). (CONF-770377—2). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 134. meeting of the Haus der Technik e.V. on non-conventional energy carriers; Essen, F.R. Germany (21 Mar 1977).

The design of an air-water heat pump and influence of the heat source (air) on the heating power and performance coefficient of the pump are discussed. Defrosting and noise abatement are also discussed. Examples of application and operating experience are presented.

10622 (AED-CONF—77-072-006) **Experience with heat pumps, the heat being taken from running waters.** Rumpf, H.G. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G., Essen (Germany, F.R.). Hauptverwaltung). May 1977. 14p. (In German). (CONF-770585—2). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Meeting on the application of energy at the final consumption stage - analysis, planning, techniques; Schliersee, F.R. Germany (17 May 1977).

An explanation of the peculiarities of flowing surface waters with regard to their suitability as heat sources for heat pumps is followed by the description of two projects. The first, a study of the use of the heat content of the Erft River shows that this river has a heat potential high enough to supply existing and proposed heat pump applications and this heat source is economical even when auxiliary oil heating is required. The second, the Schelstorstrassee Reorganization Project in Esslingen, is aimed at obtaining operating experience in order to improve the design and performance of plant components. This housing development is heated with four heat pumps which are operated individually or in combination depending on outdoor temperature conditions. Operating experience during 1976 and 1977 is reported.

10623 (CONF-770868—2) **Quantative determination of surface temperatures using an infrared camera.** Hsieh, C.K.; Ellingson, W.A. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 8p. Dep. NTIS, PC A02/MF A01.

From 21. annual technical symposium of the Society of Photo-Optical Instrumentation; San Diego, California, USA (22 Aug 1977).

A method is presented to determine the surface-temperature distribution at each point in an infrared picture. To handle the surface reflection problem, three cases are considered that include the use of black coatings, radiation shields, and band-pass filters. For uniform irradiation on the test surface, the irradiation can be measured by using a cooled, convex mirror. Equations are derived to show that this surrounding irradiation effect can be subtracted out from the scanned radiation; thus the net radiation is related to only emission from the surface. To provide for temperature measurements over a large field, the image-processing technique is used to digitize the infrared data. The paper spells out procedures that involve the use of a computer for making point-by-point temperature calculations. Finally, a sample case is given to illustrate applications of the method. 6 figures, 1 table.

10624 (NP—22648) **Energy conservation in buildings, R and D.** (Statens Inst. foer Byggnadsforskning, Stockholm (Sweden)). 1976. 62p. Dep. NTIS (US Sales Only), PC A04/MF A01.

The function of the Swedish Council for Building Research, (BFR) which is concerned with urban planning and all phases of building design, construction, and maintenance, and the research and development programs in energy planning for buildings undertaken by the BFR during 1974 to 1975 and planned to 1978 is described. This research includes collecting data on energy consumption in various sectors of the Swedish economy, determining availability of energy sources, testing building designs, construction materials, and space conditioning equipment for energy efficiency, estimating costs and benefits of building energy conservation measures, and guiding federal energy policy and planning. A table of all current projects is included. (LCL)

10625 **Heat pipe: a new technology comes of age.** Ranken, W.A. (Los Alamos Scientific Lab., NM). *Energy (Stamford, Conn.);* **2**: No. 4, 28-30(Fal 1977).

The potential of heat pipes for conservation and effective heat transfer has not yet been fully recognized, although ERDA research and development programs for heat pipe recovery are intended to find cost-effective technologies for commercial application. Heat pipes, making use of an evaporation-condensation cycle, can be applied to precision temperature control, one-way heat transmission, and the amplification and reduction of heat flux. A range of liquids from liquid hydrogen to silver and copper can be used according to the temperatures needed. The major demand is for heating, ventilating, and air conditioning systems to reduce energy consumption in buildings. Expanded use of coal resources to produce synthesis gas can make use of heat pipes in the gasifier. Designs of heat pipe methanators and the ceramic-heat pipe recuperators for high-temperature recuperation are described. (DCK)

RESIDENTIAL BUILDINGS

REFER ALSO TO CITATION(S) 10555, 10557, 10570, 10589, 10590

10626 (KFK-PDV—111) **Digital control of domestic oil burners reduces air pollution.** Birck, H.; Jacob, H.G.; Schmidt, G. (Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl und Lab. fuer Steuerungs- und Regelungstechnik). May 1977. 64p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

After a brief description of the working of oil heating plants for domestic use, experimentally obtained families of curves showing the performance of the heating plant, with respect to pollution as well as comsumption of oil, are explained. A corresponding quality criterion is derived. The simulation investigations are based on mathematical models of a standard domestic oil heating installation and of the time sequences of the typical perturbations acting on the plant. Simulation runs on heating installations without control process equipment are compared with simulation runs using programs for extremum seeking control, automatic starting commands, and self surveillance devices. The results demonstrate the effectiveness of such concepts particularly with respect to pollution suppression. The results of on-line extremum seeking control by a microcomputer controller coincide with the previous simulation runs. It is shown that digital control of domestic oil burners by microcomputers is technically and economically feasible.

10627 (NP—22607) **Annual housing survey, 1975: United States and regions. Part A. General housing characteristics.** (Department of Commerce, Washington, D.C. (USA); Department of Housing and Urban Development, Washington, D.C. (USA)). Apr 1977. 270p. GPO.

This report presents statistics on general housing characteristics for the United States by inside and outside standard metropolitan statistical areas (SMSAs). Data are based on information from a sampling of housing units, collected by personal interview from October to December 1975. Part A provides data on general housing characteristics; part B on indicators of housing and neighborhood quality; part C on financial characteristics; part D on recent mover households; part E on urban and rural housing characteristics; and part F on financial characteristics cross-classified by indicators of housing and neighborhood quality. Appendix A describes the geographic area classifications and provides definitions and explanations of the subjects covered in the report. Appendix B presents information on sample design, estimation, and accuracy of the data. (MCW)

TRANSPORTATION

REFER ALSO TO CITATION(S) 10551

10628 (CONF-760895—, pp 19-37) **Energy consumption in the transportation sector.** Dupree, W.G. (Bureau of Mines, Washington, DC). May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

Energy consumption in the transportation sector accounted for 30 percent of the total gross energy input to the U.S. economy in 1975. In mid-1976, petroleum accounted for more than 95 percent of the energy input to the transportation sector, and this dominance by petroleum is also expected to continue well into the future. The consumption of petroleum products by the transportation sector has shown some variation over time. There are six major products—liquefied gases, jet fuel, lubes and waxes, gasoline, distillate fuel, and residual fuel. Their percentage distribution over time is also documented in tabular form. Regional variations in transportation energy consumption are also documented.

10629 (CONF-760895—, pp 159-178) **Future transportation fuels: optimization of the vehicle—fuel—refinery system.** Tierney, W.T.; Wilson, R.F. May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

Current energy demand and supply patterns are reviewed, and the availability of energy resources to meet demands in the free world is projected. At current petroleum industry capital investment levels, it is shown that future domestic crude oil production will not be sufficient to significantly reduce the level of petroleum imports. Synthetic fuels from such sources as oil shale, tar sands, and coal are

also considered as replacements for imported petroleum. It is suggested that conservation coupled with incentives for new petroleum and alternate resource development can substantially reduce the United States dependence on imported petroleum. Since transportation fuels account for a large portion of liquid fuels consumption, it is shown that the vehicle, its fuel, and the refinery (VFR) must be optimized as a total system in order to provide for the most efficient utilization of our crude oil and subsequent synthetic-based fuels. Benefits to be derived from optimizing the VFR system are illustrated by a series of cases presented on the basis of applying known vehicle fuel-economy efficiencies to various transportation fuel product slates to simulate an average U.S. refinery. These computer runs show the relative fuel quantities available when a given refinery is operated to provide a fixed volume of non-automotive petroleum products and a fixed amount of transportation miles when using gasoline, diesel, broad range fuel, and future concept engines. It is concluded that system optimizations similar to the VFR system study must be more broadly applied between the various energy sources and final use devices to improve conservation in our entire spectrum of energy utilization.

10630 (CONF-760895—, pp 245-268) **Energy efficiency of current intercity passenger transportation modes.** Miller, M.P. (Boeing Commercial Airplane Co., Seattle). May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

A detailed study was conducted to compare three public modes (aircraft, train, and bus) and one private mode of transportation (automobile). The comparison represented Spring 1974 conditions and was conducted in two parts. During the first part, basic energy efficiency data were collected or developed for each mode. For the second, these data were applied to passenger transportation between 10 city pairs. These results were extended using national system trends to obtain a comparison for the total city pair population. Results from the study are presented, and the importance of establishing clear ground rules to ensure fair comparisons through consistent data is emphasized. Many earlier papers show deficiencies in this respect. Some of these deficiencies are specifically pointed out in order to explain why this paper's results differ from those of previous papers.

10631 (CONF-760895—, pp 269-296) **Intercity freight fuel utilization at low package densities: airplanes, express trains, and trucks.** Miller, M.P. (Boeing Commercial Airplane Co., Seattle). May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

This report provides a comprehensive air energy usage data for low package densities. It is emphasized that all modes do not compete in all markets and indeed modes are complementary. Mode selection varies with the specifics of each transportation requirement: trip length, market size, transport time, commodity characteristics, etc. The major objective of this paper is to explore the relationship between energy conservation and value of transportation. Several aspects of modal energy analysis are examined, including the impact of freight density on modal trip energy comparison. Only the operational energy consumption data are analyzed. The paper concludes: at average air freight density, typical express trains and typical trucks are respectively 7 and 4 times more fuel-efficient than air freighters; because of the significant quantities of freight carried in the bellies of passenger airplanes, air freighters do not necessarily represent a correct base for air cargo; the latter depends upon the passenger-airplane-trip fuel-allocation technique. The results presented in this report are markedly different from those found in published analysis which ignore the characteristics of the markets served by each mode. The author also expounds upon the fact that because of unavailability of good data here, fair comparisons have been difficult.

10632 (CONF-760895—, pp 337-349) **Transportation management and energy conservation.** Hemphill, J.G. (Federal Energy Administration, Washington, DC). May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

This paper summarizes the energy conservation impacts of various transportation management policies. The role of mass transit in alleviating the energy dilemma is discussed. It is concluded that a program package which incorporates incentives as well as disincentives is significantly more effective in reducing energy use than application of either alone. It is also emphasized that, because of the low base for mass-transit usage at the present time, there is not much potential for energy savings. The causes of the mass-transit decline are also discussed. Considerable emphasis is placed upon automobile policies such as restricted area licensing system; parking taxes and surcharges; and automobile billing of roadways. Finally, a comprehensive transportation management program approach directed towards reducing energy within the urban area is described.

10633 (CONF-760895—, pp 369-393) **Energy and economic impacts of projected freight transportation improvements.** Leilich, R.H. (Peat, Marwick, Mitchell and Co., Washington, DC). May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

The major goal of this study is to estimate the current and future energy intensity for major freight modes. The report also deals with the economic impact of anticipated changes in freight systems (trucks, railroads, inland waterways, coastal and Great Lakes Ships, pipelines, and air freight) under various assumptions about freight demands for 1980 and 1985. This report also examines the impact of certain vehicle types upon energy intensity. Statistical as well as engineering relationships are used for predicting the energy usage and intensity. The study is constrained by the nonavailability of good energy related data. It is highly recommended that attempts should be made to collect data that could enhance future studies related to energy conservation. The study concludes that ample opportunities exist for energy conservation in the freight transportation industry. The report also adds that the greatest opportunities lie with the industry itself. Government influence to improve energy conservation practices is not as potentially significant as opportunities currently available to industry. The report also deals with the regulatory changes which may have a profound impact on transportation energy conservation.

10634 **Energy and transportation.** Warrendale, PA; Society of Automotive Engineers (1976). 69p. (CONF-7510179—).

From Energy and transportation forum; Detroit, Michigan, USA (15 Oct 1975).

Papers presented at the October 15, 1975, one-day forum on "Energy and Transportation," held in Detroit are included. This forum considered the transportation needs for various forms of energy and the long-term availability of such energy sources. Papers dealing with the transportation energy needs of our nation covered passenger cars, heavy-duty trucks, aircraft, and other forms of transportation. Economic consideration and investment requirements associated with reducing our energy needs were discussed. The availability of energy as petroleum and in alternate forms was considered. Some attention was also directed toward alternate strategies which might alleviate our dependence upon petroleum. Again, investment requirements to meet our future energy needs were covered in considerable detail.

AIR AND AEROSPACE

REFER ALSO TO CITATION(S) 10588

10635 (CONF-760895—, pp 297-304) **Impacts of Civil Aeronautics Board regulatory restraints on energy conservation as it pertains to the certificated air transportation industry.** Constanz, J.C. May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

The U.S. airline industry is severely regulated by CAB and FAA regulations. Most of these regulations are old and are being questioned by several groups. These regulations affect economic and operational aspects of the industry. Some feel that the present regulations are outdated and hence are a deterrent towards the growth of the airline industry while others argue oppositely. There is a considerable interest on the part of the executive branch to look into these regulations and find ways to improve the overall productivity of the airline industry. This report deals basically with the impact of CAB regulatory restraints on energy conservation potential.

RAILWAY

REFER ALSO TO CITATION(S) 10588, 10641, 10644

10636 (CONF-760895—, pp 207-221) **Total direct and indirect costs of BART.** Healy, T.J. (Univ. of Santa-Clara, CA). May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

This paper deals with the direct and indirect energy costs of BART system. These costs are categorized amongst: traction, station, maintenance, construction, and impact energy. Energy Intensity comparison is made for several Electric Transit Systems (Philadelphia, Chicago, New York, Cleveland, Toronto). Major emphasis

of the paper is upon the indirect energy cost (construction energy) which is nearly 50 percent of the overall energy utilized for the BART system. For a comprehensive energy comparison of a given transportation system, it is important to identify not only the operational energy but also the construction energy. The author also makes a note regarding the unavailability of good data for fair comparisons.

10637 (CONF-760895—, pp 223-232) **Computer simulation of train performance for energy analysis.** Hazel, M.E. Jr. (Dept. of Transportation, Cambridge, MA). May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

This paper describes the computer simulation approach towards studying train performance. This approach is far better than the statistical approach because the researcher has a thorough knowledge of the background information such as train consists, operating speed, route characteristics, type of the products carried. Transportation Systems Center has been involved in studying the simulation of freight trains from an energy viewpoint. This paper attempts to provide the detailed information needed for simulating trains along certain routes. Input and output formats are discussed. Emphasis is also placed upon the train resistance equation and any relevant background information needed for the study.

10638 (CONF-760895—, pp 233-243) **Recent measurements of fuel consumption in rail freight service.** Hopkins, J.B. (Dept. of Transportation, Cambridge, MA). May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

Railroads carry more than one-third of the intercity freight. Although railroads are considerably fuel-efficient, still there is a great potential for energy conservation. In order to understand the quantitative aspects of fuel savings, it is important to have knowledge and detailed data in three categories: the train itself; it's route information; and its operating scenario. This report provides preliminary results of fuel efficiency; gross trailing ton-mile/gallon, as a function of train consist; and gross trailing weight in tons and speed. Related work in progress is also reported.

10639 (CONF-760895—, pp 395-403) **Rail-intermodal operation and fuel efficiency.** Randall, H.L. (CONRAIL, Philadelphia). May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

Over a long-haul, rail is an efficient mode of transportation from an energy as well as cost consideration, whereas trucks are efficient over the short-haul and provide mobility from the point of origin to destination. The integration of services between rail and truck can provide better transportation services to the consumer and can save cost and fuel. This paper deals with this subject area and expands upon the activities being undertaken by "CONRAIL" to enhance intermodal service between the truck and train.

LAND AND ROADWAY

REFER ALSO TO CITATION(S) 10588, 10608, 10639

10640 (CONF-760895—, pp 51-80) **Energy efficiency of Automated Guideway Transit Systems.** Mittal, R.K. (Union Coll., Schenectady, NY). May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

A computer program was developed for estimation of the rate of Energy Consumption for Automated Guideway Transit Systems under variable service, design, and trip characteristics. Aspects considered include examinations and evaluation of impacts of suspension systems (rubber tire, air cushion, pneumatic tire, foam-filled tires), propulsion systems (linear induction motor, rotary motors) vehicle design, (number of seats, weight), and quality of service (waiting time, distance to station, average speed, line speed). The impact of trip characteristics (length of trip, number of trips, modal split) on energy efficiency is also examined and documented. The components of energy consumption (rolling friction, aerodynamic drag, auxiliary power) under various design and operating conditions is also studied. The effect of empty vehicle shuttling on the energy efficiency index is also documented. This study provides guidelines for energy consumed by new systems and will prove valuable to planners, engineers, and politicians involved in deciding when, where, and how future urban transit systems can be implemented. The study also provides techniques for energy conservation and hopefully will serve as a needed stimulus to the urban transportation technology.

10641 (CONF-760895—, pp 81-107) **Engineering analysis and comparison of railroad and truck line-haul work (energy) requirements.** Morlok, E.K. (Univ. of Pennsylvania, Philadelphia). May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

The purpose of this paper is to compare the propulsive work requirements of line-haul movement by rail and truck in order to identify those characteristics of such movements that affect the absolute and relative amounts of energy required. This study includes rail movement in conventional cars, rail movement in truck trailers on flat cars (TOFC or piggyback), and over-the-road movement in various types of trailer trucks. Market or movement situation characteristics such as the weight and size of shipments, the average speed, and route profile conditions are varied. In order to identify the effects of varying model and market characteristics, the work requirements are estimated using engineering relationships, in contrast to most prior comparisons which have used averaged empirical (statistical) data. These engineering models yield point estimates under certain route profile conditions, while in others where an excessive amount of data on the profile would be required a few route parameters can be used to estimate a range of work requirements. These models should be generally useful in comparing energy requirements of transport modes.

10642 (CONF-760895—, pp 109-137) **Why not triples.** Hutton, T.D. Jr. May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

The size and weight of commercial motor vehicles have been effectively frozen since the adoption of the Federal Aid Highway Act of 1956. The author feels that removal of political barriers for liberalization of these restrictions will help stem the tide of inflation, while at the same time making potential fuel savings of as much as 21 percent for intercity freight trucks a reality. With transportation a recurrent cost in every phase of production, distribution, and service, fuel becoming more expensive, and the security of supply more tenuous, the significant increase in transportation efficiency provided by the triple trailer combination must not be withheld from the nation's economy, he states. Millions of operational miles have clearly demonstrated that our nation's highways have been built to the point where they can safely handle this equipment, he continues, with triples having established the best safety record of any vehicle ever used on our highways. Finally, he adds, triples make it possible to move freight with fewer vehicles, thereby reducing highway congestion, conserving energy, and consequently reducing pollution.

10643 (CONF-760895—, pp 139-158) **Selecting line haul trucks to meet fleet requirements.** Klokkenga, D.A. May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

This paper deals with the heavy duty trucks used for freight movement. Thousands of different combinations are possible for a truck, and hence the selection process becomes tedious. The simulation approach is demonstrated as a design tool for selection of the optimum truck under given conditions. Details of the truck components (engine, transmissions, driving axles, tires) and environmental factors (energy, noise level, smoke, wind) are provided. The report also deals with several conservation options (use of radial tires, wind deflectors, thermatic fan) and their quantitative impact upon fuel savings. It is concluded that the simulation approach can be extremely useful in evaluating new components at the expense of a few hundred dollars.

10644 (CONF-760895—, pp 179-206) **Energy use of public-transit systems.** Healy, T.J. (Univ. of Santa-Clara, CA). May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

This report deals with the energy efficiency of various public transit systems. Statistical as well as engineering approaches are discussed with special emphasis on impact of load factor upon energy efficiency. Comparative energy analysis is provided for the following systems: auto gas (small and large); electric auto (small, large); personal rapid transit (small, large); commuter rail; rail rapid transit; trolley; fixed-route bus; express bus; demand-responsive bus; and jitney. Data are tabulated for weight, number of seats, Btu per vehicle mile, and Btu per passenger mile. The report provides a comprehensive bibliography and documents all the pertinent as-

sumptions inherent in most of the related studies. The report also provides definitions on all the systems discussed. 30 references.

10645 (CONF-760895—, pp 305-321) **Energy and freight movement.** French, A. (Federal Highway Administration, Washington, DC). May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

This paper deals with the energy aspects of intercity freight movement via truck modes. It is emphasized that considerable detailed analysis needs to be performed before conclusions regarding energy consumption for specific situations can be made. The author expounds upon the fact that "percent empty backhaul" and "ton miles per gallon" can be misleading. Shipping density and cubage are important determinants for comparing energy efficiency comparison of various modes. Other characteristics of commodities such as value, perishability, fragility, frequency of shipment, amount to be shipped at one time, total amount to be shipped over a long period, are important factors while considering the energy efficiency comparisons over various modes. Finally, the report deals with energy intensity comparison for TOFC, COFC, and Rail.

10646 (CONF-760895—, pp 351-368) **Marketing approach to carpool demand analysis.** Hill, D.M. (Peat, Marwick, Mitchell and Co., Washington, DC). May 1977.

From 3. national conference on the effects of energy constraints on transportation systems; Schenectady, New York, USA (2 Aug 1976).

In Effects of energy constraints on transportation systems.

Improving auto efficiency has a high potential for transportation energy conservation. Various policies are evaluated such as: rationing policy; parking rate adjustment policy; toll surcharge policy; and carpool rebate incentive policy. These policies were applied to specific target groups and at levels representative of typical programs which would be administratively feasible. The details of the policies, rationale for selection, and the analytical approach are also treated. One of the policies tested, gasoline rationing, had by far the greatest impact. Parking-surcharge policies were also highly effective in reducing energy consumption. Pure incentives policies, such as rebates, improved matching, and reduced parking rates for carpools did not yield substantial energy savings. It was also concluded that the alternate use of a vehicle at home during the day is not significant and decreases energy savings marginally.

10647 (DOT-TST—77-47) **Study of efficiency indicators of urban public transportation systems. Final report.** Tomazinis, A.R. (Pennsylvania Univ., Philadelphia (USA). Transportation Studies Center). Jan 1977. 323p. NTIS.

This report presents the efforts of a research project on efficiency problems of urban public transportation systems (UPTS). Three test regions were selected in an effort to discover, clarify, and understand the efficiency relationships within UPTS. The test regions vary from a small one-mode region to a large multi-mode region. The UPTS are first divided into three major system components, i.e., primary services, support functions, and the network. Then each system is divided by mode, and each component by each distinct function carried within the system component. The inputs to the system are also divided by type, i.e., labor, capital, and energy, and according to the contributor, i.e., the operator, the direct user, the society at large, and the government at all levels. Input units are also traced in terms of money costs (Fiscal Inputs Matrix) and physical units (Physical Inputs Matrix). System outputs are also separated by the receiver and the nature of the outputs. Efficiency analysis is then explored in a hierarchical manner exploring three types of relationships, i.e., system inputs vs. system outputs; component inputs vs. component inputs; and component outputs vs. component outputs. Efficiency indicators are then discussed as to the type of useful service they may offer in various types of efficiency analysis problems.

10648 **Interagency study of post-1980 goals for commercial motor vehicles.** Washington, DC; Private Truck Council of America, Inc. (1976). 23p.

A study was made to set bus and large truck fuel economy goals compatible with environmental, safety, and economic objectives. Recommendations resulting from the study include: (1) reasonable heavy-duty vehicle emission goals be considered in the range of HC = 0.5, CO = 10, and NO/sub x/ = 3 grams per brake horsepower-hour for both gasoline and diesel engines; and (2) the development of new test and certification procedures derived from vehicle-use studies underway be accelerated and proposed as a function of vehicle-use, rather than engine type (i.e., diesel vs gasoline). Noise and safety are discussed, and legislation permitting longer, wider, and heavier vehicles nationwide is proposed. (PMA)

SEA AND WATER

REFER ALSO TO CITATION(S) 10640

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 10568

10649 **Energy management: engineering of conservation systems.** West Chester, PA; Roy F. Weston, Inc. (1975). 326p. (NP—22611).

The data and information presented was intended for use in a short course for engineers on energy conservation and management in industrial plants, and is general information not for any specific industrial process or installation. Chapters are included on the need for energy conservation; areas where conservation can be effected; measuring and controlling energy consumption; combustion of fossil fuels and industrial wastes; combustion equipment; steam generators; steam heated equipment; waste heat utilization; motors, turbines, and compressors; HVAC and lighting systems; electrical systems; water systems; thermal insulation; building design; and energy costs. (LCL)

ENERGY SOURCES

REFER ALSO TO CITATION(S) 10559, 10857

10650 (AED-Conf—77-027-001) **Determination of heat losses by means of infrared techniques.** Euskirchen, J. (Messerschmitt-Boelkow-Blohm G.m.b.H., Muenchen (Germany, F.R.)). 1977. 8p. (In German). (CONF-770378—1). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 3. meeting of the Deutsche Gesellschaft fuer Sonnenenergie e.V. on heating with sun 2 - house technology under practical aspects; Munich, F.R. Germany (3 Mar 1977).

The infrared method is an important tool in finding heat losses in houses. In countries in which it is used more, the studies are carried out more carefully. A qualitative building test should be carried out by a building specialist, but this requires better knowledge of building physics that was the case until now. This report also explains the fundamentals of the infrared technique and the mode of operation of a heat picture camera.

10651 **Alternative energy sources for the steel industry.** Szekely, J. (ed.). New York; Marcel Dekker, Inc. (1977). 128p. (CONF-7511137—).

From 6. C. C. Furnas Memorial Conference; Buffalo, New York, USA (Nov 1975).

Alternative technologies must be developed for the steel industry, which may entail the use of nuclear energy. An authoritative treatment on alternative sources is provided by Dr. D. J. Blickwede, in his keynote address, stressing that the optimal strategies have to include both common-sense measures, in order to effect conservation, and the development of new, sophisticated technologies. The more practical aspects of energy conservation in the steel industry are treated in two papers, contributed from the Republic Steel Corporation and the Steel Company of Canada. The theoretical limits of coke replacement, as supported by pilot plant experience are discussed by Dr. P. L. Woolf and an outline of a detailed survey on the potential for energy conservation in the steel industry, conducted by the Batelle Memorial Institute, is given by Dr. H. W. Lownie. Finally, a detailed report on the significant advances made in the utilization of nuclear energy as a heat source in the process industries from the German Federal Republic is given by R. Schulten and K. Kugeler. (MCW)

EQUIPMENT AND PROCESSES

REFER ALSO TO CITATION(S) 10570, 10592, 10856

10652 **Method for starting operation of a resistance melter.** Chapman, C.C. (to Energy Research and Development Administration). US Patent 4,017,674. 12 Apr 1977. Filed date 16 Jan 1976. 6p. PAT-APPL-649,770.

A method for starting the operation of a resistance furnace is described. Heating occurs by passing a current through the charge between two furnace electrodes, and the charge is a material which is essentially electrically nonconductive when in a solid physical state but which becomes more electrically conductive when in a molten physical state. An electrical resistance heating wire is connected between the furnace electrodes, placing the wire in contact with the charge material between the electrodes and passing a current through the wire to heat the wire to a temperature sufficient to melt the material between the furnace electrodes. As the material melts, current begins to pass between the electrodes through the melted material, further heating and melting more material until all current between the electrodes passes through the charge material without the aid or presence of the resistance element.

10653 (NP—22194) **Findings and recommendations of the task force on combustion controls and instrumentation.** (New York State Office of General Services, Albany (USA)). 16 Dec 1970. vp. Inst., Inc., Fullerton, CA.

Methods of handling combustion control and instrumentation used at 62 high-pressure heating plants were examined to determine changes in these methods that would result in improved fuel conservation safety and reliability and reduced operating and maintenance costs. The results of this study are presented and recommendations are given for inspecting, maintaining, and repairing combustion control equipment, for training personnel using the equipment, for evaluating the economics of the recommended procedures. (LCL)

10654 (TREE—1174) **Energy oriented study of industrial cyclone separators.** Cox, N.D.; Richardson, A.S.; Jensen, W.P. (EG and G Idaho, Inc., Idaho Falls (USA)). Sep 1977. Contract EY-76-C-07-1570. 40p. Dep. NTIS, PC A03/MF A01.

This study was conducted to obtain data for an estimate of the current and anticipated energy demand for the operation of industrial cyclone separators. The information sources used were technical papers and texts on the subject and a survey of manufacturers of cyclone separators. Estimates of the nationwide energy consumption of single gas cyclones, multiple tube gas cyclones, and liquid cyclones were obtained separately. These were added to obtain the total consumption for the three types. To this total was added an energy consumption estimate for the wet cyclone scrubbers manufactured by a single company. The final estimate of the gross annual energy consumption of cyclone devices is 0.38 exajoule (0.37 quad). The total energy consumption of cyclone separators will probably grow at a pace commensurate with that of industry as a whole. Immediate energy conservation can be achieved by using cyclones in series with other solids-collecting unit operations in such a way as to minimize energy consumption. Many systems designers are doing this now, but a more imaginative examination of alternatives is urged. A breakthrough in designing cyclones for reduced energy consumption, while maintaining collection efficiency, seems possible. Research in this area is recommended.

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 10582

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 10571, 10614, 10659

10655 **Removal of Zn or Cd and cyanide from cyanide electroplating wastes.** Moore, F.L. (to Energy Research and Development Administration). US Patent 4,026,790. 31 May 1977. Filed date 7 Mar 1975. 4p.

PAT-APPL-556,353.

A method is described for the efficient stripping of stable complexes of a selected quaternary amine and a cyanide of Zn or Cd. An alkali metal hydroxide solution such as NaOH or KOH will quantitatively strip a pregnant extract of the quaternary ammonium complex of its metal and cyanide content and regenerate a quaternary ammonium hydroxide salt which can be used for extracting further metal cyanide values.

MUNICIPALITIES AND COMMUNITY SYSTEMS

PUBLIC UTILITIES

REFER ALSO TO CITATION(S) 10582, 10583, 10584, 10585, 10586, 10587

10656 (CONF-770939—1) **Dynamics and control studies of a MIUS coal-fired gas turbine experiment.** Ball, S.J. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 19p. Dep. NTIS, PC A02/MF A01.

From 3. power plant dynamics, control and testing symposium; Knoxville, Tennessee, USA (7 Sep 1977).

The fluidized-bed coal-fired gas turbine experiment is part of the Modular Integrated Utility System program, which is jointly sponsored by the Department of Housing and Urban Development and the Energy Research and Development Administration. The dynamic characteristics of the experiment are investigated to determine specific control system designs required to satisfy varying electrical and waste heat demands and, at the same time, to keep plant component temperatures and stresses within acceptable limits. The simulations indicate that the present control system design is capable of handling expected transients satisfactorily.

10657 (NBS-SP—468, pp 27-40) **Economics of failures in energy generation systems.** Lapides, M.E. (Electric Power Research Inst., Palo Alto, CA). Apr 1977.

From Prevention of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

Capital equipment costs and efficiency of fuel utilization are well recognized criteria in the selection of new electrical generation capacity. The service reliability of the equipment, as measured by some term which reflects both the productivity of the investment and the consequential cost impacts of failure is an equally important, albeit somewhat more elusive, consideration. The purpose of this paper is to illustrate what forms of failure can be encountered with utility generation equipment and what the consequential impact of these failures is on the cost of electrical generation. This background material, which is specifically developed for large, baseload generation units, is then used to describe some suggested orientations for failure prevention in advanced technology systems.

MUNICIPAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 10571

10658 (COGEMA-BIB—1) **Pyrolysis as waste processing.** Auchapt, J.M. (Compagnie Generale des Matieres Nucleaires (COGEMA), Centre de Marcoule, 30 - Bagnols-sur-Ceze (France)). Jan 1977. 35p. (In French). Dep. NTIS (US Sales Only), PC A03/MF A01.

A report is given showing that pyrolysis, as a semi-achieved incineration is a possible method of lowering the cost of firing wastes. Some characteristics of the process are given, and the different types of apparatus employed in pilot or industrial plants are reviewed.

10659 **Method for the abatement of hydrogen chloride.** Winston, S.J.; Thomas, T.R. (to Energy Research and Development Administration). US Patent 4,038,369. 26 Jul 1977. Filed date 14 Nov 1975. 6p.

PAT-APPL-632,027.

A method is described for reducing the amount of hydrogen chloride contained in a gas stream by reacting the hydrogen chloride with ammonia in the gas phase so as to produce ammonium chloride. The combined gas stream is passed into a condensation and collection vessel and a cyclonic flow is created in the combined gas stream as it passes through the vessel. The temperature of the gas stream is reduced in the vessel to below the condensation temperature of ammonium chloride in order to crystallize the ammonium chloride on the walls of the vessel. The cyclonic flow creates a turbulence which breaks off the larger particles of ammonium chloride which are, in turn driven to the bottom of the vessel where the solid ammonium chloride can be removed from the vessel. The gas stream exiting from the condensation and collection vessel is further cleaned and additional ammonium chloride is removed by passing through additional filters.

EDUCATION AND PUBLIC RELATIONS

REFER ALSO TO CITATION(S) 10649

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

SPARK-IGNITION

REFER ALSO TO CITATION(S) 10664, 10672, 10673

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 10644, 10661

10660 **ERDA says: electric cars by 1982.** Ann Arbor, MI; Ann Arbor Science Publishers Inc. (1977). 15p.

A brief discussion is given of the research programs dealing with electric-powered vehicles which have been contracted by the US Energy Research and Development Administration. Progress in electric battery development, regenerative braking and flywheels is discussed, and a forecast is given of various technology advancements. Photographs are presented of several electric vehicle prototypes. (PMA)

HYBRID SYSTEMS

10661 (UCRL—79153) **Theoretical performance upgrading of the E.V.A. electric vehicle by use of a flywheel/battery hybrid power train system.** Davis. D.D.; Epps, R.C.; Renner, R.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Jan 1977. Contract W-7405-ENG-48. 46p. (CONF-770430—3). Dep. NTIS, PC A03/MF A01.

From 4. international symposium on automotive propulsion systems; Washington, District of Columbia, USA (17 Apr 1977).

The performance improvement that could be realized by an electric vehicle through replacement of the existing electric drive train with one incorporating a flywheel/battery energy source is examined. The vehicle selected for the theoretical power train conversion is the electric sedan marketed by Electric Vehicle Associates (E.V.A.). The hybrid power train proposed, uses a high-energy composite flywheel coupled to a simple, efficient, electromechanical transmission. The lead-acid batteries installed by E.V.A. provide the prime power source. Interactive control of battery and/or flywheel drive power is provided by a versatile microprocessor-based power control unit. The flywheel allows efficient recovery of vehicle kinetic energy during braking and provides the energy base required to meet all high power transient demands. The flywheel also stabilizes battery demand at a low average value resulting in improved battery performance through increases in both cycle life and available energy. Due to the hybrid system described here, electric vehicle acceleration and range improvements are predicted to be in excess of 80% for the E.V.A. vehicle when operated in a stop-and-go commuter environment.

FLYWHEEL PROPULSION

REFER ALSO TO CITATION(S) 10661

VEHICLE DESIGN FACTORS

REFER ALSO TO CITATION(S) 10648

ENGINE-TRANSMISSION MATCHING

10662 **Foaming and air entrainment in automatic transmission fluids.** Dixon, L.T.; Korcek, S. Warrendale, PA; Society of Automotive Engineers (1976). 10p. (CONF-760678—8).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, Missouri, USA (8 Jun 1976).

The Ford Dynamic Aeration Test Apparatus is used to evaluate the foaming, air entrainment and air release properties of selected automatic transmission fluids. By this method it is possible to evaluate fluids under conditions which approach those of the automatic transmission operation. The effects of changes in aeration rate, temperature, pressure and air humidity on the foaming and air entrainment characteristics are evaluated and a rating procedure for automatic transmission fluid behavior is suggested.

10663 **Extended life for transmission components through limited air breathing.** Christiansen, F.A.; Dunn, J.R.; Ross, W.D. Warrendale, PA; Society of Automotive Engineers (1976). 8p. (CONF-760678—15).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, Missouri, USA (8 Jun 1976).

Eight Ford C6 transmissions were operated in a San Francisco cab fleet for up to 89,000 miles (143,000 km) with zero, or minimal fluid make-up and with the transmissions effectively sealed to prevent air breathing. The after-test condition of the fluid and of the synthetic rubber seals differs sufficiently from all similar test experienced, with the single exception of the data presented in a previous paper on the TABS valve.

ENGINE SYSTEM

REFER ALSO TO CITATION(S) 10666, 10667

10664 (SAND—77-8270) **Summary of variable-displacement engine project.** Robinson, C.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1977. Contract EY-76-C-04-0789. 21p. (CONF-771037—1). Dep. NTIS, PC A02/MF A01.

From ERDA contractors' coordination meeting; Detroit, Michigan, USA (4 Oct 1977).

A variable-displacement, five-cylinder, spark-ignition research engine has been designed, fabricated, and tested. This design reduces partial-load fuel consumption by reducing throttling and friction losses. Power is controlled by changing the piston stroke rather than by throttling, except at idle and very low power levels. A linkage arrangement allows for continuous changes in stroke and therefore in engine displacement. The prototype has a bore of 3.375 inches, and stroke varies from 1 to 4 1/4 inches as displacement varies from 43 to 190 cubic inches. The linkage concept is such that clearance volume can be changed in proportion to the stroke. Thus nearly constant compression ratio can be achieved, or (by proper selection of the linkage dimensions) compression ratio can be tailored to optimize the design. During design, dynamic analyses of various configurations of the engine were done to determine member loads and unbalanced forces and to assist in selecting the linkage configuration. Dynamic analysis was also used to select five as the number of cylinders, to determine the firing order to reduce engine vibration, and to compare vibration with that of a conventional engine. An engineering model of the engine fluid dynamics was also developed and was used to predict engine performance, to select cam contours, and to optimize cam timing.

10665 **Multiple fuel supply system for an internal combustion engine.** Crothers, W.T. (to Energy Research and Development Administration). US Patent 4,031,864. 28 Jun 1977. Filed date 9 Mar 1976. 6p.

PAT-APPL-665,191.

A multiple fuel supply is described for an internal combustion engine wherein phase separation of components is deliberately induced. The resulting separation permits the use of a single fuel tank to supply components of either or both phases to the engine. Specifically, phase separation of a gasoline/methanol blend is induced by the addition of a minor amount of water sufficient to guarantee separation into an upper gasoline phase and a lower methanol/water phase. A single fuel tank holds the two-phase liquid with separate fuel pickups and separate level indicators for each phase. Either gasoline or methanol, or both, can be supplied to the engine as required by predetermined parameters. A fuel supply system for a phase-separated multiple fuel supply contained in a single fuel tank is described.

EMISSION CONTROL

REFER ALSO TO CITATION(S) 10648, 10903

10666 **Effect of bare engine noise on diesel trucks.** Young, T.C. Warrendale, PA; Society of Automotive Engineers (1976). 8p. (CONF-760678—13).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, Missouri, USA (8 Jun 1976).

A study was made of the relative correlation between (1) bare engine sound levels, (2) engine contributing sound levels in the vehicle, and (3) total vehicle sound levels. Common statistical analytical programs are used as the method of correlation.

10667 **Diesel engine noise: basic studies lead to practical reductions.** Coulson, J.; Southall, R. Warrendale, PA; Society of Automotive Engineers (1976). 15p. (CONF-760678—14).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, Missouri, USA (8 Jun 1976).

Early work aimed at diesel engine noise reduction is described. This has led to an intensive research program to develop a method of predicting engine noise. A special research engine incorporating the latest noise control features is described. The research engine is additionally used to verify the predictive technique, and the analysis completed to date is discussed.

NITROGEN OXIDES

REFER ALSO TO CITATION(S) 10670, 10671, 10672, 10673, 10674, 10675, 10677

CARBON MONOXIDE

REFER ALSO TO CITATION(S) 10670, 10672, 10673, 10674, 10675

HYDROCARBONS

REFER ALSO TO CITATION(S) 10670, 10672, 10673, 10674, 10675

ALTERNATIVE FUELS

REFER ALSO TO CITATION(S) 10665

10668 (LBL—6841) **Catalyzed combustion in a flat plate boundary layer. I. Experimental measurements and comparison with numeri-**

cal calculations. Robben, R.; Schefer, R.; Agrawal, V.; Namer, I. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1977. Contract W-7405-ENG-48. 54p. (CONF-771015—6). Dep. NTIS, PC A04/MF A01.

From Fall meeting of the Western States Section of the Combustion Institute; Palo Alto, California, USA (17 Oct 1977).

A classic fluid mechanics boundary layer problem, flow over a sharp leading edge flat plate, was used to study the effect of a heated surface on combustion in lean hydrogen-air mixtures. The velocity and density profiles of the boundary layer have been measured with laser Doppler velocimetry and Rayleigh scattering, respectively. Preliminary measurements on a silicon dioxide "non-catalytic" surface indicate neither boundary layer nor surface combustion for wall temperatures up to 1250°K. Measurements on a platinum catalytic surface indicate that, at a surface temperature of 1000°K, not only is there significant surface combustion but that homogeneous combustion in the boundary layer is induced by active species generated at the catalytic surface.

10669 (UCRL—52313) **Alternative fuels for transportation: implications of the broad-cut option.** Anderson, C.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 11 Jul 1977. Contract W-7405-ENG-48. 18p. Dep. NTIS, PC A02/MF A01.

Broad-cut liquid hydrocarbon fuels (roughly equivalent to equal mixtures of gasoline and diesel fuel) could lead to important fuel savings through more efficient engines and fuel production. Broad-cut fuels could be made initially from petroleum and ultimately from coal, oil shale, or other economical sources. Engines designed for the fuels might include direct-injected, stratified, turbine, stirling, or spark-assisted diesel engines. 4 tables, 6 figures, 12 references.

10670 Single cylinder spark ignition engine study of the octane, emissions, and fuel economy characteristics of methanol—gasoline blends. Johnson, R.T.; Riley, R.K. Warrendale, PA; Society of Automotive Engineers, Inc. (1976). 14p. (CONF-750264—2).

From Automotive engineering congress and exposition; Detroit, Michigan, USA (24 Feb 1975).

A two phase test program was carried out on a single cylinder, fuel research engine (CFR) to determine the octane, emissions, and fuel economy characteristics of methanol-gasoline blends. The first phase of the work was an evaluation of the octane characteristics of methanol blended with unleaded gasoline. Blends ranging from 2% to 100% by volume methanol for four different base gasolines were knock rated. A simplified mathematical model of the results was developed to aid in comparing the effects of methanol on the octane ratings of the various base fuels. The results indicate that methanol can substantially increase both the Research and Motor Ratings of a relatively low octane unleaded gasoline. The second phase of the test program was an evaluation of the emissions and fuel economy of a 10% by volume blend of methanol with two base fuels in the single cylinder engine. Clear Indolene and a 95 RON commercial gasoline were used for these tests. The results for the Indolene blend are presented since both fuels behaved in a similar manner. Where differences did exist appropriate comments are included. General conclusions were that a blend of 10% methanol and gasoline demonstrated no significant change in the emissions or energy efficiency over the gasoline fueled engine when operated at equivalent conditions. Under some operating conditions, the addition of methanol could increase the octane rating of the base fuel. This increase could conceivably be enough to reduce knock problems in some vehicles.

10671 Recent progress in the hydrogen engine. Escher, W.J.D.; Ecklund, E.E. Warrendale, PA; Society of Automotive Engineers (1976). 12p. (CONF-760678—6).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, Missouri, USA (8 Jun 1976).

Developments in the energy and environmental sectors have awakened interest in hydrogen-fueled internal combustion engines. Based on a 50-engine survey of recent U.S. research and demonstration activities, the technical status of hydrogen engines is summarized. A comparative hydrogen/conventional-fuel orientation is maintained in assessing basic fuel property, engine power and efficiency, emissions and general operating characteristics. Key theoretical and experimental results, and correlations where evident, are noted. Engine problem areas and their solutions are discussed, accompanied by some thoughts toward future development possibilities and supporting research needs.

10672 Performance of methanol-gasoline blends in a stratified charge engine vehicle. Johnson, R.T.; Riley, R.K.; Dalen, M.D. Warrendale, PA; Society of Automotive Engineers (1976). 11p. (CONF-760678—9).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, Missouri, USA (8 Jun 1976).

A series of driveability and chassis dynamometer tests were performed using various blends of methanol and gasoline in a stratified charge engine vehicle. The vehicle used was a 1975 Honda Civic CVCC. This vehicle is powered by a prechamber type stratified charge spark ignition engine. The test program was separated into two phases. The first phase was to determine the effect of methanol-gasoline blends on the driveability of the stratified charge engine vehicle. Blends containing 10% to 40% by volume of methanol in gasoline were tested. A weighted demerit system was used to evaluate driveability. Emissions and fuel economy of the vehicle operating on base fuels and base fuels blended with methanol were evaluated using a chassis dynamometer and the federal urban driving schedule. General conclusions are that the CVCC vehicle tested suffered only slight degradation in driveability using a 10% methanol-gasoline fuel and vehicle emissions and fuel economy are not significantly changed by use of the 10% methanol blend.

10673 Converting a small car to LNG: what are the problems and what can it do for economy and emissions. Affleck, W.S.; Harrow, G.A.; Mills, W.D. Warrendale, PA; Society of Automotive Engineers (1976). 16p. (CONF-760678—10).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, Missouri, USA (8 Jun 1976).

A two liter compact car originally designed to run on gasoline was converted to run on LNG. Comparative measurements of fuel economy and exhaust emission were made for the same car running on each fuel under normal on-the-road and simulated taxi service. When tuned to its maximum economy configuration, the LNG car gave significant improvements in fuel economy when expressed on an energy basis. For inter-urban journeys the savings would be of the order of 5% and for taxi type service in excess of 20%. When set for maximum economy the LNG car gave significantly lower emissions of CO and hydrocarbons than its gasoline counterpart. Emissions of NO/sub x/ were, however, higher with LNG than with gasoline. A tenfold reduction in NO/sub x/ emissions could be obtained by re-tuning the LNG engine to run at air/fuel ratios up to 30:1. Hydrocarbon emissions with this configuration were, however, quite high and would require supplementary means of control. When tuned to operate at very weak mixtures the car remained quite driveable but was 10 to 15% less economical than when tuned for maximum economy.

10674 Technical and economical aspects of methanol as an automotive fuel. Koenig, A.; Lee, W.; Bernhardt, W. Warrendale, PA; Society of Automotive Engineers (1976). 13p. (CONF-760678—12).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, Missouri, USA (8 Jun 1976).

The results of basic test series conducted on a single-cylinder engine are used to establish the reasons that advocate the introduction of methanol or methanol-gasoline blends as alternative fuel for motor-vehicle operation: lower exhaust emission concentrations, improved energy utilization, higher engine output, and improved knock-resistance. Fuel and energy consumption data are submitted for four vehicle concepts operated on methanol fuels, to establish data on the economic aspects of methanol-operated vehicles. It is apparent that the utilization of the antiknock effects of methanol can lead to competitive gasoline-methanol blend vehicle operation at the present cost of gasoline and methanol. Vehicle operation of pure methanol would offer economic advantages over gasoline operation if gasoline is derived from coal.

10675 Water-gasoline fuels: their effect on spark ignition engine emissions and performance. Peters, B.D.; Stebar, R.F. Warrendale, PA; Society of Automotive Engineers (1976). 21p. (CONF-760678—11).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, Missouri, USA (8 Jun 1976).

Single-cylinder engine tests, an analytical engine cycle simulation, and automobile tests were employed to study the effects of supplementing gasoline with water for use in spark ignition engines. Factors examined include: the method of water addition (both water-in-gasoline emulsions and direct manifold water addition), antiknock characterisitics with water additione, MBT spark requirement, indicated engine efficiency, engine cooling requirement, exhaust emissions, volumetric efficiency, lean operating limit, smoke level, exhaust temperature, and vehicle driveability. Among the negative aspects of water addition were increased hydrocarbon emissions and decreased vehicle driveability. Also, the polyoxyethylene type of emulsifier used in the water-in-gasoline emulsions, gave poor fuel stability and caused a rapid buildup of engine deposits. However on the positive side, water-gasoline fuels have higher octane ratings and decrease nitric oxide emissions.

10676 Advances in hydraulic oil additive technology. Papay, A.G. Warrendale, PA; Society of Automotive Engineers (1976). 10p. (CONF-760678—16).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, Missouri, USA (8 Jun 1976).

The status of hydraulic oil additive technology is briefly reviewed with emphasis on recent advances. New test methods now being introduced into the industry are examined and results of comparative testing presented. A comprehensive analysis and performance comparison is made of the two main technologies: ashless and zinc dithiophosphate. It is shown that the ashless (S, P) approach is superior to the zinc-based one in most performance areas and offers industry the option for a truly multipurpose hydraulic oil.

10677 Hydrogen fuel in the subcompact automobile. Billings, R.E. Warrendale, PA; Society of Automotive Engineers (1976). 9p. (CONF-760678—17).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, Missouri, USA (8 Jun 1976).

Recent advances in hydrogen energy technology have made possible the consideration of a subcompact automobile utilizing metal hydrides, or powdered hydrogen storage, and a low cost electrolyzer for vehicle recharging. Basic considerations of the metal hydride automotive system are discussed regarding various vehicular prototypes. Particular emphasis is placed on a hydrogen minicar application. Utilizing a low cost electrolyzer and utility grid electricity for vehicle recharging, it is possible to make a comparison of the metal hydride hydrogen engine system with other electric vehicles on the basis of storage weight, vehicle range, and cost of operation.

MATERIALS

METALS AND ALLOYS

REFER ALSO TO CITATION(S) 9582, 9596

10678 Reactive plasma cleaning of metals. Kominiak, G.J.; Mattox, D.M. (Sandia Labs., Albuquerque, NM). *Thin Solid Films;* **40**: 141-148(1977).

From International conference on metallurgical coatings; San Francisco, CA, USA (5 Apr 1976).

Reactive plasmas formed in an rf discharge are effective in removing contaminants and barrier layers from a variety of metals. Reactive dc discharges are ineffective. A mixture of argon (90-99%) with a reactive gas or a gas which will decompose to a reactive species in the discharge was used in the rf reactive plasmas. A soft X-ray appearance potential spectrometer was used for in situ surface analysis to evaluate the surface cleaning. Carbon-containing gases, such as those used in reactive plasma etching, left a carbon residue on the surface. Oxygen additions to the reactive plasma, such as are used in reactive etching, prevented cleaning of the metal surfaces. Reactive plasmas containing hydrochloric acid were the most effective. Reactive plasma cleaning in Ar—HCl was as effective as rf sputter cleaning and could be accomplished at much lower power levels. For example, reactive plasma cleaning of titanium was accomplished in 90 min using 500 V rf and 30 W in an Ar-5% HCl plasma. Similar rf sputter cleaning required 90 min at 2 kV rf and 600 W in Ar. It is proposed that the reactive species reacts with the surface, forming compounds which are more easily volatilized or sputtered.

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 10514

10679 Effects of temperature and bias on the composition of rf-sputtered Te—As—Ge ternary films. Bolker, B.F.T. (Gould Labs., Rolling Meadows, IL). *J. Vac. Sci. Technol.;* **14**: No. 1, 254-258(1977).

Previous investigation has shown that a combination of rf cosputtering, film-temperature control, and substrate bias control can produce ternary films with a range of different compositions from a single basic target configuration. Some of the detailed relationships between film composition in the Te—As—Ge ternary system and film-deposition parameters, especially film temperature and film bias, are described in this present research. The main sputtering target was $Te_{75}As_{25}$. Ge was the cosputtered element, and it contributed theoretically predicted amounts of material to the films up to the 16½-at. % Ge level. Substrate temperature and substrate bias had a strong influence on the As/Te ratio of the films, but had little effect on the Ge content. The Te content of the film decreased for substrate temperatures between -150°C and +20°C. This temperature effect appeared to be linear. Application of an rf bias caused a linear decline in the Te content of the films. These effects are interpreted in terms of sticking coefficient and preferential resputtering. The addition of Ge enhanced the Te content in the film and this effect is examined in terms of bond energies.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 10701

10680 (ORNL—5340) **Composition of eta carbide in Hastelloy N after aging 10,000 hr at 815°C.** Leitnaker, J.M.; Potter, G.A.; Bradley, D.J.; Franklin, J.C.; Laing, W.R. (Oak Ridge National Lab., Tenn. (USA)). Nov 1977. Contract W-7405-ENG-26. 26p. Dep. NTIS, PC A03/MF A01.

The composition of the eta carbide in Hastelloy N containing 0.7 wt percent Si in the alloy approaches $M_{12}C$, rather than M_6C as indicated in the alloy literature. The silicon content of the eta phase in this case was about 25 at. percent, much higher than has been observed in less highly alloyed material. The data do not permit a definition of the limiting compositions of the phases.

10681 Electron and positron densities and the temperature dependence of the positron lifetime in a vacancy in aluminum. Gupta, R.P.; Siegel, R.W. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **39**: No. 19, 1212-1215(7 Nov 1977).

The results of an augmented-plane-wave calculation of the electron and positron density distributions in a vacancy in Al are reported. The environment of the vacancy was simulated by a super cell with a volume 27 times that of the primative unit cell. These results show that jellium-model calculations overestimate the electron density in a vacancy. The variation of the positron lifetime associated with thermal expansion of the lattice is also presented..

10682 Plutonium-rhodium Pu_5Rh_4. Cromer, D.T. (Los Alamos Scientific Lab., N.Mex. (USA)). *Acta Crystallogr., Sect. B;* **33**: No. 6, 1993-1995(15 Jun 1977).

Pu_5Rh_4, Pnma, Z=4, a=7.276(2), b=14.332(4), c=7.419(2)A, rhosub(c)=13.79 g cm^{-3}. Data were collected on an automatic diffractometer. The structure was solved by direct methods and refined by full-matrix least squares. Rsub(w)=0.0417 for 1063 observed reflections. Pu-Pu distances range from 3.316 to 3.945 A, Pu-Rh distances from 2.714 to 3.214A and Rh-Rh distances from 2.749 to 3.826A. The structure is similar to those of Sm_5Ge_4 and Gd_5Si_4.

10683 Plutonium—iridium Pu_5Ir_3. Cromer, D.T. (Los Alamos Scientific Lab., N.Mex. (USA)). *Acta Crystallogr., Sect. B;* **33**: No. 6, 1996-1997(15 Jun 1977).

Pu_5Ir_3, I4/mcm, Z=4, A=11.012(3), c=5.727(2)A, rhosub(c)=16.94 g cm^{-3}, for an approximately stoichiometric alloy. For an Ir-rich alloy a=11.015(3), c=5.621(2)A. This structure is of the D8sub(m) (W_5Si_3) type. For the Ir-rich alloy it is postulated that some Ir is substituted in the 0, 1/2, 1/4 Pu site.

10684 Hyperfine fields at impurity sites in iron. Watson, R.E. (Brookhaven National Lab., Upton, N.Y. (USA)); Bennett, L.H. (National Bureau of Standards, Washington, D.C. (USA)). *Physica, B, C;* **86**: No. 88, 435-436(1977).

From International conference on magnetism; Amsterdam, The Netherlands (6 - 10 Sep 1976).

Controversy has recently revived concerning the correlation of hyperfine fields at impurity atom sites in ferromagnetic iron with atomic volume or with valence. Using a scheme to normalize to the free atom hyperfine field, the authors inspect the correlations of volume, valence and electronegativity with new normalized values.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 10201, 10234, 11172

10685 Shear moduli of a niobium single crystal with hydrogen additions at elevated temperature. Schlader, D.M.; Smith, J.F. (Ames Laboratory: ERDA and Department of Materials Science and Engineering, Iowa State University, Ames, Iowa 50011). *J. Appl. Phys.;* **48**: No. 12, 5062-5066(Dec 1977).

The independent elastic constants of a niobium single crystal were measured over the temperature range 298—600 K. Concentrations of 1.90 and 4.69 at.% hydrogen were successively introduced at 573 K through a palladium coating. Elastic shear constants were determined at both concentrations. The data show that C_{44} increases and C' decreases with increasing hydrogen concentration, but the slopes of both concentration dependences decrease so that the slope of the concentration dependence of the anisotropy ratio is insensitive to temperature. Both increasing temperature and increasing hydrogen concentration tend to move the anisotropy ratio toward unity.

10686 Inelastic deformation of pressurized stainless steel tubes under synamic bending and torsional loading. Larson, L.D. (Bettis Atomic Power Lab., West Mifflin, PA); Stokey, W.F. *J. Pressure Vessel Technol.;* **99**: 258-263(May 1977).

From American Society of Mechanical Engineers conference on petroleum mechanical engineering and pressure vessels and piping; Mexico City, Mexico (19 Sep 1976).

A test program was conducted to investigate the inelastic response behavior of internally pressurized tubes subjected to dynamic bending and torsion loads. The basic experiment was a drop test in which the cantilever tube was dynamically loaded by a torque arm with a concentrated weight at the end. The experimental data consist of strain versus time records and peak and permanent deflections. Analytical predictions of the response were made using a lumped parameter beam model of the structure. This simple representation of the pressurized tube is made possible by use of an approximate analytical model for the inelastic deformation of a pipe element subjected to pressure, bending and torsion. The predicted responses are compared with measured responses to assess the accuracy of the models.

10687 Creep analysis of metallic structures in the presence of thermal gradients using newer constitutive relations. Kumar, V.; Mukherjee, S. (Cornell Univ., Ithaca, NY). *J. Pressure Vessel Technol.;* **99**: 272-280(May 1977).

From American Society of Mechanical Engineers conference on petroleum mechanical engineering and pressure vessels and piping; Mexico City, Mexico (19 Sep 1976).

Several newer constitutive relations have recently been proposed for describing the mechanical behavior of metals and alloys under elevated temperature creep conditions. A salient feature of the mathematical structure of many of these relations is that they typically express the nonelastic strain rates as functions of the current values of stress, temperature, and some other suitably defined state variables. A computational scheme is presented in this paper for the inelastic analysis of metallic structures subjected to both mechanical and thermal loadings and obeying constitutive relations of the type described before. Several numerical examples for the creep of thick-walled spheres, cylinders, and rotating disks in the presence of thermal gradients are presented. The particular constitutive relations used in these calculations are due to Hart. The proposed computational scheme is found to be very efficient from the viewpoint of both computational time and effort. The effects of previous cold work on the stress redistribution and creep of these structural elements are discussed.

10688 Interpretation of high-temperature creep of Type 304 stainless steel. Chopra, O.K.; Natesan, K. (Argonne National Lab., IL). *Metall. Trans., A;* **8**: 633-638(Apr 1977).

The elevated-temperature creep behavior of Type 304 stainless steel is examined in terms of the measured effective and internal stresses. Results show that the mean effective stress is related to the applied stress by a power law of the form sigma* = α(sigma)/sup β/, where the constants α and β are functions of temperature. The dependence of creep rate on applied stress follows a power law, and the stress exponent is dependent on temperature. The latter behavior arises from the variation in the mean effective stress with applied stress and temperature. The creep rates are also described as a function of effective stress. The dislocation velocity-stress exponent obtained from stress-change tests is higher than the effective stress exponent evaluated from creep data. The dependence of creep rate on temperature at various values of effective stress yields a total activation energy of approximately the same magnitude as self-diffusion.

10689 Elastic—plastic fracture mechanics. Rice, J.R. (Brown Univ., Providence). pp 23-53 of In Mechanics of fracture, AMD. Vol. 19. New York; American Society of Mechanical Engineering (1976).

This is a review of elastic-plastic fracture mechanics as related to processes of crack growth in ductile and semi-ductile structural metals. The topics discussed include asymptotic and numerical results on the stress analysis of cracks, J Integral methods for the onset of crack extension, microstructural processes of brittle and ductile fracture and their relation to macroscopic fracture toughness, and models for stable crack growth.

PHYSICAL PROPERTIES

10690 Temperature dependence of the relaxation time of the superconducting order parameter. Schuller, I.; Gray, K.E. (Argonne National Lab., Ill. (USA)). *Solid State Commun.;* **23**: No. 5, 337-340(Aug 1977).

Measurements have been made of the temperature dependences of the relaxation time of the superconducting order parameter and of the equilibrium energy gap close to the transition temperature in very clean films of aluminum. The results are only consistent with the temperature and energy gap dependence predicted by Schmid and Schon (J. Low Temp. Phys.; 20:207 (1975)). It is also shown that the magnitude and mean free path dependence of the electron inelastic collision time is in good agreement with calculations.

10691 Neutron scattering study of magnetic ordering in the reentrant superconductor $ErRh_4B_4$. Moneton, D.E.; McWhan, D.B.; Eckert, J.; Shirane, G.; Thomlinson, W. (Bell Laboratories, Murray Hill, New Jersey 07974). *Phys. Rev. Lett.;* **39**: No. 18, 1164-1166(31 Oct 1977).

Using neutron scattering techniques, we show that the destruction of superconductivity in $ErRh_4B_4$ at T/sub c/ = 1.0 K is accompanied by the development of long-range ferromagnetic ordering of the Er sublattice. The observed magnetic Bragg intensities indicate that the Er ion has a moment of 5.6μ/sub B/ which is oriented in the tetragonal basal plane. The magnetic transition appears second order, but shows anomalously strong precusor scattering.

10692 Magnetostrictive and magnetic properties of single crystals of terbium—yttrium alloys. Nikitin, S.A.; Andreenko, A.S.; Posyado, V.P.; Chuprikov, G.E. (Moscow State University). *Sov. Phys. - Solid State (Engl. Transl.);* **19**: No. 6, 1045-1048(Jun 1977).

It is shown, on the basis of an investigation of the magnetostriction and of the magnetic and electric properties of a system of single crystals of terbium—yttrium alloys, that the concentration and temperature regions in which helicoidal antiferromagnetic and ferromagnetic states exist are determined by the changes of the magnetostriction and by the topology of the Fermi surface.

10693 Hysteresis and ion yield minimum during electron stimulated desorption of oxygen on W(100). Yu, M.L. (Brookhaven National Lab., Upton, N.Y. (USA)). *Surf. Sci.;* **64**: No. 1, 334-338(Apr 1977).

Electron stimulated desorption (ESD) of oxygen ions O^+ from oxygen covered W(100) surfaces have been studied extensively. In this paper the O^+ sub(ESD) yield during the adsorption of oxygen at temperatures of 400, 1400 and 1600 K is studied. The yield during gradual thermal desorption is also investigated. Static mode secondary ion mass spectrometry was used to monitor the amount of oxygen on the surface so that O^+ sub(ESD) signals at various oxygen coverages could be compared both during adsorption and desorption.

10694 Magnetic moment distribution of ferromagnetic Ni—Rh alloys. Cable, J.W.; Wollan, E.O. (Oak Ridge National Lab., TN). *Physica, B, C;* **86-88**: 745-746(1977).

The diffuse scattering of polarized and unpolarized neutrons was used to determine the spatial distribution of the magnetic moment for ferromagnetic Ni-Rh alloys. The average Ni moment remains near 0.6 μ/sub B/ to 12 at. % Rh and then decreases toward zero at the critical concentration of 37 at. % Rh. There is an initial rapid decrease in the Rh moment that follows a P_{12} dependence and corresponds to a moment of 2 μ/sub B/ for isolated Rh atoms. The data indicate moment fluctuations at both the Ni and the Rh sites that are associated with local environment.

10695 Pressure dependence of the Neel temperature of fcc stainless steel. Rhiger, D.R.; Ingalls, R.; Liu, C.M. (Univ. of Washington, Seattle). *Solid State Commun.;* **18**: No. 6, 681-683(1976).

The Neel temperature T/sub N/ of fcc stainless steel has been measured as a function of pressure using the Moessbauer effect. A sample with approximately 74 wt % Fe, doped with ^{57}Co, and having T/sub N/ = 58.4 +- 0.1 K at zero pressure, shows T/sub N/ rising with pressure with increasing slope. Our results indicate that T/sub N/ is raised to room temperature by a pressure of 175 +- 5 kbar.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 9546, 9556, 9563, 9581, 9583, 9584, 9585, 9586, 9588, 9591, 9606, 9625, 9627, 10037, 10203, 10208

10696 (SVF—26) Material tests in deaerated 20 % NaOH and 20 % NaOH+5% NaCl solutions at 325°C. Final report. Johansson, B.J.E. (Stiftelsen foer Vaermeteknisk Forskning, Studsvik (Sweden)). Sep 1976. 19p. (In Swedish). Dep. NTIS (US Sales Only), PC A02/MF A01.

In SVF Project 30: 'Comparative corrosion tests of different tube materials for PWR steam generators' the materials AISI 321, alloy 800, alloy 600, Inconel 690 and Nickel 201 have been autoclave tested in deaerated 20% NaOH and 20% NaOH+5% NaCl solutions at 325 deg C as to stress corrosion cracking resistance. In all 374 single and double U-bends from 15 different heats in at least one and up to as many as five different material conditions have been exposed up to 2000 h in both environments (2500 h regarding shot-peened U-bends from four heats). Nickel 201 was found to be entirely resistant to stress corrosion cracking in both environments. All the remaining materials showed on the contrary cracking to a varying degree. Thus alloy 800 showed better resistance to stress corrosion cracking than alloy 600 in both environments and was found to be the most resistant alloy next to Nickel 201. Shot-peening was found to be very effective in checking stress corrosion

cracking in these environments, without causing any appreciable deterioration of the general corrosion resistance of the materials.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 10203

10697 Absorbing precipitates in cadmium telluride: estimates for catastrophic laser-damage thresholds. Bennett, H.S.; Cantrell, C.D. (U. S. National Bureau of Standards, Washington D.C. 20234). *Appl. Opt.;* **16**: No. 11, 2931-2933(Nov 1977).

One problem frequently encountered in high-power laser systems is thermal extrinsic damage to the laser materials, which arises from absorbing inclusions. In this paper the maximum tensile stresses as a function of inclusion size, laser pulse width, and laser power are estimated for the common precipitates in CdTe.

10698 High temperature, ultra high vacuum facility for heavy ion simulation of neutron radiation damage to potential reactor materials. Smith, H.V. Jr.; Lott, R.G. (Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering). *Nucl. Instrum. Methods;* **143**: No. 1, 125-132(15 May 1977).

The University of Wisconsin-Madison facility for simulating neutron damage to potential reactor materials is described. Heavy metal ions from a tandem accelerator bombard metal specimens heated as high as 1000°C at pressures below 10^{-8} torr. Special features of the facility include a radiation heater assembly which allows integration of the beam current, an ultra high vacuum environment which is characterized by partial pressure analysis, use of 15-20 MeV heavy metal ions to induce the damage in the specimens, and direct measurement of the beam composition. This facility is suitable for studying radiation effects in the refractory metals as well as other potential reactor materials.

10699 Effect of carbon on void formation in neutron-irradiated nickel. Sorensen, S.M. Jr; Chen, C.W. (Ames Lab., Iowa (USA)). *Radiat. Eff.;* **33**: No. 2, 109-118(1977).

The effect of carbon on void formation in neutron-irradiated high purity nickel was investigated using transmission electron microscopy. After irradiation to fluences ranging from 4.0×10^{18} to 2.0×10^{20} n/cm^2 ($E > 0.1$ MeV) at 500 and 710°C, voids were found in specimens containing up to 84 wppm carbon, whereas void formation was not observed in specimens with 600 wppm carbon. The present results have thus revealed a pronounced suppressing effect of interstitial carbon atoms on void formation. The quantitative analysis on void size and density indicates that the effect of carbon is mainly on void nucleation, not on void growth. A trapping mechanism, based on a relatively large divacancy-carbon atom complex binding energy of 0.86 eV, is proposed in which the dissolved carbon atoms are assumed to effectively trap at least two vacancies per carbon atom. This trapping mechanism is dynamic in nature because 'free' interstitial carbon atoms are quite mobile in the nickel lattice at and above 500°C.

10700 Low-swelling stainless key to LMFBR development. Obrzut, J. *Iron Age:* **217**: No. 2, 34-35(12 Jan 1976).

Stainless steel Type 316 or any other stainless used in liquid-metal fast breeder reactors can swell deleteriously under certain conditions by bombardment with intense high-energy neutrons. This irradiation-induced swelling can be reduced 5 to 10 times by additions of Ti and Si to the stainless composition. A table of Type 316 and alloys with lower Cr compositions with Ti and Si additions is shown. With such modified chemistry more Pu can be bred from each fission atom and the breeder reactor will be able to operate at higher power levels. A test was developed to screen alloys quickly by bombarding the test alloys with Ni ions from the Oak Ridge National Laboratory's 5.5 MV Van de Graaff accelerator. Cold working could possibly further improve the resistance of the new alloys to swelling.

10701 Lattice location studies of gases in metals. Vook, F.L.; Picraux, S.T. (Sandia Labs., Albuquerque, NM). *Adv. Chem. Ser.;* **14**: No. 158, 308-324(1976).

Ion channeling and nuclear microanalysis techniques can determine the crystallographic lattice locations of implanted or dissolved gases in single crystal metals. Ion-induced nuclear reaction, x-ray, or backscattering measurements of channeling angular yield distributions along specific axes and planes clearly indicate lattice locations of gases for high symmetry sites. Interstitial and substitutional sites can be clearly distinguished. Light gas atoms such as hydrogen and oxygen occupy well defined interstitial positions, whereas heavier noble gas atoms do not occupy well defined interstitial or substitutional sites. In bcc metals deuterium is located in tetrahedral sites in W, Cr, and Mo at low temperature and in distorted octahedral sites in Cr and Mo at higher temperatures. For implanted He in W, multiple He atoms are trapped by lattice vacancies.

CERAMICS, CERMETS, AND REFRACTORIES

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 9768

10702 Arc-melting preparation of single crystal LaB_6 cathodes. Gibson, E.D.; Verhoeven, J.D. (to Energy Research and Development Administration). US Patent 4,030,963. 21 Jun 1977. Filed date 27 Jan 1976. 6p.

PAT-APPL-652,695.

A method for preparing single crystals of lanthanum hexaboride (LaB_6) by arc melting a rod of compacted LaB_6 powder is discussed. The method is especially suitable for preparing single-crystal LaB_6 cathodes for use in scanning electron microscopes (SEM) and scanning transmission electron microscopes (STEM). 1 figure, 1 table.

10703 Parametric study of silicon carbide coatings deposited in a fluidized bed. Federer, J.I. (Oak Ridge National Lab., TN). *Thin Solid Films;* **40**: 89-96(1977).

From International conference on metallurgical coatings; San Francisco, CA, USA (5 Apr 1976).

Silicon carbide coatings have been deposited on microspheres in a fluidized bed by the reaction of methyltrichlorosilane and hydrogen. The principal variables of reactant gas composition and temperature were correlated with the morphology, the microstructure and the density of the coating. The effect of the coating rate on these characteristics was shown to be slight. The optimum gas composition for highly dense coatings was about 5 vol % or less methyltrichlorosilane in H_2. The amount of grown-in porosity increased as the gas composition increased above 5 vol % methyltrichlorosilane in H_2. The optimum temperature for highly dense coatings was in the range 1475-1675°C. Lower temperatures resulted in silicon-rich deposits, while higher temperatures caused unacceptable porosity.

10704 Titanium carbonitrides obtained by chemical vapor deposition. Pierson, H.O. (Sandia Labs., Albuquerque, NM). *Thin Solid Films;* **40**: 41-47(1977).

From International conference on metallurgical coatings; San Francisco, CA, USA (5 Apr 1976).

A preliminary investigation was made of hard abrasion-resistant coatings obtained by the chemical vapor deposition of titanium carbonitrides with the objectives of (1) developing a process with an upper temperature limit of 650°C to avoid altering the properties of substrates such as steel and (2) establishing a relation between the properties of the coatings and the deposition parameters. By using amines as a source of carbon and nitrogen, uniform and adherent coatings were obtained at deposition temperatures of 550°C to 650°C, provided the steel substrate was electroplated with nickel or cobalt to prevent the formation of interfacial iron chlorides. X-ray diffraction showed that the lattice parameter of the coatings deposited with trimethylamine increased with higher deposition temperatures with a corresponding increase in the carbide mole percent, which rose from 25% at 550°C to 72% at 650°C. The lattice parameter and the carbide mole percent were higher with trimethylamine than with dimethylamine (53% and 30%, respectively, at 600°C).

STRUCTURE AND PHASE STUDIES

10705 Lattice dynamics of V_3Si. Rumyantsev, A.Y.; Zemlyanov, M.G.; Parshin, P.P.; Chernoplekov, N.A.; Usov, O.A.; Marchenko, V.A. *Sov. Phys. - Solid State (Engl. Transl.);* **19**: No. 6, 1001-1003(Jun 1977).

The method of inelastic coherent neutron scattering was used to determine the phonon dispersion relations along the symmetry directions [100] and [110] in V_3Si at room temperature. The results are compared with calculations using the Born—von Karman approach and with calculations using a two-band model. The first model gives better agreement, even when only nearest-neighbor interactions are considered.

10706 Absorption of light by "drops" of the metallic phase near the semiconductor—metal phase transition in VO_2. Gerbshtein, Y.M.; Smirnova, T.V.; Chudnovskii, F.A. (Physico-technical Institute of Low Temperatures, Ukrainian Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 10, 445-446(20 May 1977).

Absorption of light by "drop" of the metallic phase has been observed in a VO_2 film long before the temperature of the phase transition into the metallic state is reached.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 10442

PHYSICAL PROPERTIES

10707 Field-electron emission from cerium dioxide whisker crystals. Strigushchenko, I.V. (Institute of Radio Engineering and Electronics, Academy of Sciences of the USSR, Moscow). *Sov. Phys. - Solid State (Engl. Transl.);* **19**: No. 6, 1118-1119(Jun 1977).

The current-voltage characteristics of the field-emission currents from CeO_2 whiskers single crystals, 3-4μ in diameter and 8-10μ in length, were studied. Along with the work function, the temperature and pressure dependences of the currents were determined.(AIP)

10708 New type of magnetic domains in multisublattice antiferromagnets. Dzyaloshinskii, I.E. (L. D. Landau Institute of Theoretical Physics, USSR Acadmey of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 9, 414-415(5 May 1977).

With UO_2 as an example, a new type of domain walls is indicated, separating phases in which the spin orientations cannot be made congruent by continuous rotation. These walls always have microscopic (atomic) thickness.

10709 Method for vaporizing mixed oxide fast reactor fuels for animal inhalation studies. Allen, M.D.; Kaune, W.Y.; Craig, D.K. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). *Health Phys.;* **32**: No. 5, 389-396(May 1977).

High-powered lasers were used to vaporize zirconium dioxide and uranium dioxide to show the feasibility of laser vaporization of UO_2-PuO_2 fast reactor fuels to generate condensation aerosols for animal inhalation studies. Three types of pulsed lasers were used: a CO_2 gas laser with an energy output of 0.2 J/pulse, a ruby laser with an output of 8 to 10 J/pulse, and a neodymium-YAG laser with an output of approx. 35 J/pulse. An incandescent vapor plume resulted from each pulse for all three types of lasers, with the plume size dependent on beam energy. The aerosol, which was visually observed for each type of laser, was collected on membrane filter paper. The amount of aerosol collected on the filter paper per pulse was directly proportional to the energy density of the beam. Scanning electron micrographs of the aerosol showed branched chains composed of spherical particles of 0.1 μm diameter which are typical of the vaporization-condensation aerosols of most solids. X-ray diffraction analyses showed that the aerosol was primarily amorphous, with diffraction patterns from a few of the samples indicating simple cubic structure. Lack of structure in most of the samples was attributed to the fast quench of the laser plume.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 9549, 9556, 9587

RADIATION EFFECTS

10710 Raman scattering study of ion bombardment induced amorphization of SiC. Wright, R.B.; Gruen, D.M. (Argonne National Lab., Ill. (USA)). *Radiat. Eff.;* **33**: No. 3, 133-140(Aug 1977).

Lattice disorder induced by ion bombardment of SiC surfaces has been studied using Raman spectroscopy. After bombardment with 15 keV H^+, D^+ of He^+ to fluences of 10^{19} cm^{-2} the SiC surface was found to amorphize as indicated by changes in the Raman spectra. Raman studies of the annealing behavior of the damaged surface showed that no recrystallization of the amorphous layer occurred after 12 hours at 1000°C. By using different wavelengths of the exciting radiation the spatial distribution of the ion induced damage was investigated. Evidence for the preferential sputtering of Si resulting in a carbon rich surface layer is discussed.

POLYMERS AND PLASTICS

REFER ALSO TO CITATION(S) 9637

OTHER MATERIALS

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 9768, 9863, 9865, 9882, 9883, 9884, 9885, 9887, 9893, 9894, 9895, 9896, 9898, 9901, 9903, 9904, 9908, 9910, 9911, 9912, 9913, 9914, 9915, 9917, 9918, 10537, 10545

PROPERTIES

REFER ALSO TO CITATION(S) 9768, 10156, 10745, 10847, 10886, 11069

10711 (COO—2203-7) Critical phenomena in thick films of a binary liquid mixture. Jacobs, D.T. (Colorado Univ., Boulder (USA). Dept. of Physics and Astrophysics). 1976. Contract EY-76-S-02-2203. 125p. Dep. NTIS, PC A06/MF A01.

Thesis.

The first experimental data on the behavior of a critical system as it approaches two dimensionality are presented. Measurements of the bulk coexistence curve by use of refractive index techniques were done on the binary fluid mixture methanol—cyclohexane. These measurements gave the critical exponent $\beta = 0.326 +- 0.003$, which agrees with recent Ising-model calculations. This same binary fluid mixture was then constrained between two highly reflective, optically flat pieces of fused silica in an interferometer. The critical temperature and coexistence curve were determined as the spacing between the flats was varied from 1 μm to 60 μm. The critical temperature was directly measured for spacings between 3 and 60 μm. It was found that, if the walls were close enough together (less than or equal to 6 μm), then the drops that form on phase separation would span the intervening space. The coexistence curves of these thick films (less than or equal to 6 μm) were determined from measurements of the difference in refractive index between the two phases that appeared as drops. It was found that the shift in the critical temperature as the spacing was varied followed a logarithmic dependence. Such a dependence is not expected from Scaling Theory for an Ising model, but is to be expected of systems with effectively infinite-range interactions. The coexistence curves for each spacing of the thick film indicated that the critical exponent β was close to 0.5, which is the mean-field (infinite-range-interaction) value and not the two-dimensional Ising-model value of 0.125. The amplitude of the coexistence curves was found to vary with spacing as L/sup z/ with z in the range $0.6 \rightarrow 0.8$. This was a much larger dependence than expected from the theory. 29 figures, 5 tables

10712 Optical and photoconductive properties of discharge-produced amorphous silicon. Zanzucchi, P.J.; Wronski, C.R.; Carlson, D.E. (RCA Laboratories, Princeton, New Jersey 08540). *J. Appl. Phys.;* **48**: No. 12, 5227-5236(Dec 1977).

Optical and photoconductive properties of discharge-produced amorphous silicon (a-Si) of the type used in efficient thin-film solar cells have been studied as a function of a wide range of deposition conditions. The optical absorption, optical band gap, photoconductivity, hydrogen content, and the characteristics of the Si-H vibrational mode in a-Si were determined. Both substrate temperature in the range ~200—400 °C and the type of discharge used are found to be important factors in determining the measured optical and photoconductive properties of a-Si. For films produced at substrate temperatures near 200 °C, dihydride bonding occurs, and the optical band gap is about 1.7 eV. As the substrate temerature increases, monohydride bonding is favored, the optical band gap decreases, the optical absorption increases, and the photoconductive properties improve. These properties are, in part, associated with the presence of bonded hydrogen. For substrate temperatures between 300 and 400 °C, the photoconductive properties are not strongly affected by changes in the substrate temperature, but are strongly influenced by the deposition technique. The Si-H bond is shown to be stable to thermal treatments at or below the deposition temperature. This is critical for the stability of a-Si properties in the fabrication of solar cells and other devices at elevated temperatures.

10713 Magnetic properties of lanthanum manganite with monoclinic and cubic perovskite structure. Sirota, N.N.; Pavlov, V.I.; Lashkov, E.S.; Karavai, A.P. (Institute of Solid State and Semiconductor Physics, Belorussian Academy of Sciences, Minsk). *Sov. Phys. - Solid State (Engl. Transl.);* **19**: No. 6, 1020-1022(Jun 1977).

The properties of lanthanum manganite with monoclinic perovskite structure, synthesized under various technological regimes, were investigated by magnetic and neutron-diffraction methods. It is shown that the magnetic properties of lanthanum manganite correlate with its crystal structure, and particularly with the degree of monoclinic distortions of the perovskite lattice.

10714 Extended x-ray-absorption fine structure (EXAFS) and its application to surface structure. Stern, E.A. (Univ. of Washington, Seattle). *J. Vac. Sci. Technol.;* **14**: No. 1, 461-465(1977).

A discussion is given of a new class of methods to ascertain the configuration of adsorbates on surfaces. This class uses the extended x-ray-absorption fine-structure (EXAFS) effect, which can be simply related to the local environment about atoms of a particular element. Both ordered and disordered arrays of atoms can be studied and directions perpendicular and parallel to the surface can be distinguished. The results of an EXAFS study of Br_2 adsorbed on Grafoil are summarized, illustrating the detailed information obtainable by this technique. It is found that at 0.2 monolayer coverage at room temperature Br_2 adsorbs as molecules. One atom of the molecule is fixed to the graphite substrate with the other atom free to flop around randomly. The location of the fixed Br atom is also determined.

10715 Pressure dependence of the Neel temperature in FeF_2. Garcia, G.A.; Ingalls, R. (Univ. of Washington, Seattle). *J. Phys. Chem. Solids;* **37**: 211-213(1976).

A Moessbauer measurement of the pressure dependence of the Neel temperature in FeF_2 is reported. Up to the maximum pressure of 50 kbar T/sub N/ increases at the rate of 0.27 +- 0.03°K/kbar. When this pressure dependence is converted to volume dependence, the result, d ln T/sub N//d ln V = 3.2 +- 0.3, is found to obey the "10/3 rule" established by Bloch for a wide variety of antiferromagnetic insulators.

10716 (UCRL-Trans—11278) **Use of p-T equilibrium curves in setting up temperature scales.** Zhokhovskii, M.K. Translated from *Izmer. Tekh.;* No. 11, 50-54(1974). 14p. Dep. NTIS, PC A02/MF A01.

The equation of the p-T curve of vaporization was obtained. This equation is capable of giving a good description of experiments of a metrological level of accuracy, which are used in setting up temperature scales. Computer calculations were performed to optimize the values of two experimentally determined coefficients. The bulk of the work concerned ^4He and ^3He, although some calculations were done for H, Ne, O, and N. The more reliable the experimental data, the more accurately they are expressed by the equation. It is capable of describing experiments with high accuracy over a wide range of pressure changes (as much as 10^6). The equation was used to identify the existence of two curves of vaporization for ^4He and to reveal the anomalous conduct of the p-T curve for ^3He. It can be recommended for the analytical description of segments of the practical temperature scale. 3 figures, 4 tables. (RWR)

CORROSION, EROSION, AND DEGRADATION

REFER ALSO TO CITATION(S) 10207

RADIATION EFFECTS

10717 Optical properties of ZnS single crystals irradiated with fast neutrons. Morozova, N.K. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **42**: No. 6, 648-653(Jun 1977).

The effect of irradiation with fast neutrons at dosages from 10^{13} to 10^{20} n/cm² on the optical properties of α-ZnS single crystals grown from the melt is investigated. It is shown that the monotonically increasing number of radiative defects in the lattice during irradiation leads with increased dosage to a vanishing of the intrinsic and, in particular, the exciton and edge luminescence of ZnS. Irradiation with doses to 10^{17} n/cm² inclusive almost never affects or insignificantly increases the intensity of luminescent bands connected with impurity centers. Doses above 10^{17} n/cm² cause the destruction of associated centers in ZnS. For doses of about 10^{20} n/cm² destruction of the crystal structure and its recrystallization with the formation of microregions of mixed structure occur.

10718 Mechanical characteristics of lithium fluoride bombarded by high-energy electrons. Garber, I.R.; Malik, A.K. (Kharkov Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR). *Sov. Phys. - Solid State (Engl. Transl.);* **19**: No. 6, 959-962(Jun 1977).

We have investigated the dependence of the yield point and of the microhardness of lithium fluoride bombarded by electrons of energy 20—250 MeV on the irradiation dose. It is shown that the microhardness at a dose $5x10^{17}$ el/cm² is increased by two times, and the yield point is increased by 3—45 times, depending on the dose. Increasing the electron energy from 25 to 250 MeV at a dose $5x10^{16}$ el/cm² causes the microhardness to increase by 20% and the yield point to increase by 50%. With increasing dose, the difference between the values of the investigated characteristics which are connected with the increase of the energy, decrease. A comparison of the obtained results with the data on bombardment by other types of particles has shown that the most effective hardening action is exerted on the lithium-fluoride crystals by high-energy electrons. The obtained experimental results are reduced on the basis of the dislocation theory of radiation hardening. The dependence of the yield point on the irradiation dose is satisfactorily described by the equation where Phi is the integral dose of the beam. The appreciable improvement in the mechanical characteristics after the irradiation leads to the assumption that the hardening is a consequence of formation of not only point defects but also of more complicated vacancy complexes. Bombardment by relativistic electrons, as shown by estimates of the energy transferred by the electron in elastic collision with the atom (ion) can lead to lattice damage of the type of depleted zones that are produced at the earliest stages of the bombardment and contribute to the athermal formation of clusters. Photonuclear reactions produce about 1% of the defects. The dimensions of the clusters and their density are estimated.

10719 Recoil contribution to ion-implantation energy-deposition distributions. Brice, D.K. (Sandia Lab, Albuquerque, NM). *J. Appl. Phys.;* **46**: No. 8, 3385-3394(Aug 1975).

A previous method for directly calculating the spatial distribution of energy deposition into damage or ionization for ions implanted into solid targets is extended to account for energy transport by recoiling target atoms. The new calculations extend the applicability of the method to lower incident ion energies. In addition, an intermediate step in the calculations provides information on the spectrum of target recoil atoms. Good agreement is obtained between experiment and theory by use of the improved procedure. Calculated damage energy distributions are presented for 10-keV to 1-MeV B, P, As, and Sb ions incident on silicon.

CHEMISTRY

10720 (LBL—6742) **Chemistry, population, resources.** Calvin, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 24 Aug 1977. Contract W-7405-ENG-48. 49p. (CONF-770950—1). Dep. NTIS, PC A03/MF A01.

From 26. meeting of the international union of pure and applied chemistry; Tokyo, Japan (4 Sep 1977).

Chemistry plays a central role in the global development of the world's human population and their resources. Its effect is exercised primarily through (1) the production of food, (2) public health, and (3) medical practice and drugs. These factors together have increased the life expectancy at birth of the population throughout the world. While such an increased life expectancy constitutes a significant social and personal value, it has been a major contributor to explosive growth of the world's population in the last century. Parallel with this has been the role of chemistry in developing the materials and the energy required by this growing population. The development of new materials, primarily organic, has placed a double strain upon the world's energy resources. We are now feeling the shortage, particularly of fossilized photosynthetic energy, whose rate of discovery is falling the world over. Chemistry is clearly the core of knowledge required to find replacements. Ways of finding these replacements are discussed: coal, solar, photosynthesis, alcohol, and hydrocarbons (synthesis by plants). 24 figs.

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 9643, 9645

10721 Determination of uranium and impurities in Portuguese yellow-cakes. Tavares, M.de J.; Barros, J.S.E.; Matos, F. (Junta de Energia Nuclear, Sacavem (Portugal). Lab. de Fisica e Engenharia Nucleares). *Talanta;* **24**: No. 5, 326-328(May 1977).

A method is described for separation of impurities in uranium yellow cakes from Urgeirica (Portugal). The trace metals are separated and concentrated by solvent extraction from 6M nitric acid into 100% TBP. The raffinate is then analysed directly by flame spectrometry. Uranium is determined gravimetrically after stripping of the organic phase. The method is fast and economic, and the results are in good agreement with those obtained by specific methods for each element after prior separation of uranium by precipitation or solvent extraction with various solvents.

10722 (UCID—15644-77-1) **General Chemistry Division quarterly report, January—March 1977.** Harrar, J.E. (ed.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Jun 1977. Contract W-7405-ENG-48. 80p. Dep. NTIS, PC A05/MF A01.

Reported are: development of analytical capabilities of a submillimeter spectrometer; improved minimum detectibility of laser-induced molecular fluorescence; use of laser photoionization sources for analytical mass spectrometry; photoacoustic spectroscopy of solids; development of time-resolved spectroscopy for multicomponent mixtures; excited-state reactions of $Ba^+ + N_2O \rightarrow BaO + N_2$; development of an ion-cyclotron-resonance spectrometer; development of glow-discharge multielement analytical systems; analysis of deposits on exploding gold bridgeware detonators; results of ^{13}C-NMR study of toluene-2,4-diisocyanate polymers; analysis of 1,6-hexanediamine and 1,3-dipiperiodylpropane; studies of discrepancies between chromatographic and mass spectrometric data; development of automated oil shale mass spectrometer; determination of minerals in oil shales; determination of H_2S in geothermal plant flue gas; characterization of geothermal brine and solids; screening of materials for use in geothermal brine; numerical studies of combustion processes; development of emission spectrometer for U in water and sediments; measurements of lanthanide ionization potentials; development of microwave multi-gas analyzer; and studies of coagulation processes of aeresols. (JRD)

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 9622

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 10875, 11008, 11016

10723 (COO—3126-37) **Nuclear and radiochemical techniques in chemical analysis. Progress report, August 1, 1976—July 31, 1977.** Finston, H.L.; Williams, E.T. (City Univ. of New York, N.Y. (USA); Brooklyn Coll., N.Y. (USA). Dept. of Chemistry). Jul 1977. Contract EY-76-S-02-3126. 76p. Dep. NTIS, PC A05/MF A01.

The neutron temperatures of the BNL Medical Reactor and in the V-11 facility of the HFBR were determined to be 48°C and 39°C, respectively. ^{22}Na resonance energy is less than 0.01 eV. The development of PIXE (Proton Induced X-Ray Emission) technique and operation of the Dynamitron have reached the point where large numbers of samples can be routinely analyzed with high sensitivity. Aerosal samples are being collected in downtown Manhattan; being analyzed for the various constituents as a function of particle size, time and elevation. Samples of marine sediment and sludge are also being analyzed by PIXE for their metal content. PIXE technique has also been applied for analyses of a variety of archaeological artifacts, human tissue, paint, and geological specimens. The metastable isomers /sup 204m/Pb, /sup 199m/Hg, /sup 111m/Cd, /sup 115m/In and /sup 87m/Sr have been produced by inelastic neutron scattering by 3 MeV neutrons and the excitation functions determined. A study of the reaction $^{19}F + P \rightarrow \alpha + {}^{16}O + \gamma$ for the determination of "freons" in the atmosphere has been initiated. The study of hydrogen overvoltage at single crystal electrodes will be continued. The effect of varying dichromate concentration on the pH of perchloric acid solutions is the same as previously observed for hydrochloric acid solutions, proving that it was not an effect of the medium. The effect on pH has also been verified over a wider pH range up to 4.4. Electrophoresis studies of chromium species show 3 different species; with one specie 1 at pH 1, one at pH 2 to 10.5, and one at pH more than 4.60. Homogeneous solvent extraction of Fe(III), Cu(II), Ni(II), Zn(II), Pb(II), Cd(II), Ca(II) Ba(II) and Mg(II) with solutions of TTA in propylene carbonate have been investigated. (DLC)

10724 **Method of determining whether radioactive contaiminants are inside or outside a structure.** Lattin, K.R. (to Energy Research and Development Administration). US Patent 4,031,387. 21 Jun 1977. Filed date 5 Aug 1976. 6p.

PAT-APPL-711,926.

A measure is obtained of the relative quantities of radioactive material inside and outside a structure such as a pipe by obtaining two spectra of gamma radiation on a dummy structure of the same shape and composition. A first spectrum is obtained with a quantity of the radioactive element to be measured located inside the structure and a second spectrum is obtained with a quantity of the same contaminant located outside the structure. 4 claims, 3 figures. The two spectra are normalized to the same equivalent value in a portion of the spectrum that does not reflect the presence of gamma rays resulting from Compton scattering in the structure. Comparison of that portion of the spectra obtained where Compton scattering is a factor gives a measure of the relative amounts of contaminants inside and outside the structure on a spectrum obtained from a test structure. The invention may also be practiced by obtaining a plurality of spectra at varying known concentrations inside and outside the dummy structure. 4 claims, 3 figures.

SEPARATION PROCEDURES

10725 **Process for separation of the rare earths by solvent extraction.** Mason, G.W.; Lewey, S. (to Energy Research and Development Administration). US Patent 4,016,237. 5 Apr 1977. Filed date 8 Sep 1975. 4p.

PAT-APPL-611,272.

Production rates for solvent extraction separation of the rare earths and yttrium from each other can be improved by the substitution of di(2-ethylhexyl) mono-thiophosphoric acid for di(2-ethylhexyl) phosphoric acid. The di(2-ethylhexyl) mono-thiophosphoric acid does not form an insoluble polymer at approximately 50 percent saturation as does the former extractant, permitting higher feed solution concentration and thus greater throughput. 5 claims, 1 figure.

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 9559, 9640, 10051, 10514, 10723, 10740

10726 (ORNL/MIT—240) **Control of discoloration in photographic waste streams.** Mbu, J.B.; Dershowitz, D.J.; Monge, J.J. (Massachusetts Inst. of Tech., Oak Ridge, Tenn. (USA). School of Chemical Engineering Practice). 26 Oct 1976. Contract W-7405-ENG-26. 40p. Dep. NTIS, PC A03/MF A01.

A reaction between aqueous sodium hypochlorite and powdered activated carbon was investigated. The reaction appeared to be composed of two first order reactions, one much faster than the other. The reaction rate increased with increasing temperature and decreasing pH, with rate constants fitting an Arrhenius expression. Filtered solution samples obtained after extensive reaction had a deep brown color which could not be separated by filtration or ultracentrifugation, but could be precipitated with lanthanum nitrate.

10727 **Cesium-133 nuclear magnetic resonance study of complexation by cryptand C222 in various solvents: evidence for exclusive and inclusive complexes.** Mei, E.; Popov, A.I.; Dye, J.L. (Michigan State Univ., East Lansing). *J. Am. Chem. Soc.;* **99**: No. 20, 6532-6536(28 Sep 1977).

The chemical shift of the ^{133}Cs resonance was studied as a function of the mole ratio of cryptand C222 to Cs^+ at various temperatures in six solvents, pyridine, acetone, propylene carbonate, N,N-dimethylformamide, acetonitrile, and dimethyl sulfoxide. The variation of the chemical shift with the mole ratio was used to determine the apparent complexation constants at temperatures high enough to yield a single, exchange-narrowed line. At lower temperatures, complete line-shape analysis was used to determine apparent exchange rates. The limiting chemical shift at high C222/Cs^+ mole ratios was found to be strongly dependent upon both solvent and temperature but converged to a solvent-independent value of -245 +- 5 ppM (downfield) at low temperatures. The behavior of the chemical shift and the variation of the line shape and apparent activation energy with temperature suggest the presence of two types of 1 : 1 complexes in solution, an exclusive complex in which the ion may interact with the solvent, and an inclusive complex which has a solvent-independent chemical shift. The temperature dependence of both the thermodynamic and the rate parameters is consistent with this model.

10728 **Quenching and quenching reversal of tris(2,2'-bipyridine)ruthenium(II) emission in polyelectrolyte solutions.** Meisel, D.; Matheson, M.S. (Argonne National Lab., IL). *J. Am. Chem. Soc.;* **99**: No. 20, 6577-6581(28 Sep 1977).

The emission from the lowest charge transfer excited state of $Ru(bpy)_3^{2+}$ is very efficiently quenched by low concentrations of Cu^{2+} ions when polyvinylsulfate (PVS) is present in the solution. Stern—Volmer constants 2 x 10^3 higher than in the absence of PVS can be easily obtained. This efficient quenching completely vanishes and the emission is nearly totally restored when higher concentrations of the same quencher, or of inert cations, are added. The efficient quenching results from Cu^{2+} and $Ru(bpy)_3^{2+}$ residing in the potential field of the same polymer. However, as soon as the quencher (or the inert cation) displaces $Ru(bpy)_3^{2+}$ from the polyelectrolyte, quenching reversal is observed. Quantitative results regarding the number of available sites and the relative binding constants of Cu^{2+} and $Ru(bpy)_3^{2+}$ can be deduced from the minima and the quenching reversal portions of the quenching curves. Possible utilization of this or similar systems in solar energy conversion and storage is indicated.

10729 **Mixed valence interactions in di-μ-oxo bridged manganese complexes.** Cooper, S.R.; Calvin, M. (Univ. of California, Berkeley). *J. Am. Chem. Soc.;* **99**: No. 20, 6623-6630(28 Sep 1977).

The complexes $[(L)_2MnO_2Mn(L)_2]^{3+}$ where L = 2,2'-bipyridine or 1,10-phenanthroline, have been examined, in addition to the corresponding (IV, IV) complex of phenanthroline. The crystal structure of the mixed valence (III, IV) compound with L = 2,2'-bipyridine demonstrated that this complex has deeply trapped valences, corresponding to class II in the classification of Robin and Day since the bond lengths differ considerably about the manganese ions. We have examined the electronic spectrum of the (III, IV) complexes and observed broad bands in the near infrared which we have assigned to the mixed valence band expected for a class II system. No comparable band is observed for the phenanthroline (IV, IV) complex. Lowering the pH of (III, IV) dimer solutions reversibly cleaves the antiferromagnetically coupled (III, IV) dimers as determined by the increase in solution magnetic susceptibility; loss of the near infrared band occurs with dimer cleavage, although the remainder of the visible spectrum is substantially unaltered. Both absorbance and solution magnetic susceptibility changes with pH are reversible. The solvent dependence of the near infrared band is small but apparently opposite to that predicted by Hush's theory. However, the bandwidths agree well with those predicted from Hush's treatment (e.g., 0.53 μm^{-1} predicted, 0.46 μm^{-1} observed). A band at 688 cm^{-1} in the infrared spectrum of the bipyridyl (III, IV) dimer is shifted by isotopic substitution with ^{18}O, and has been assigned to one of the stretching modes of the Mn_2O_2 bridge; analogous bands are found for the phenanthroline (III, IV) and -(IV, IV) complexes. Pertinent aspects of the electrochemistry are also discussed.

10730 **Recent findings on the chemical regime of steam generators.** Bosholm, J. (Ingenieurhochschule Zittau (German Democratic Republic). Sektion Kraftwerksanlagenbau und Energieumwandlung). *Kernenergie;* **20**: No. 8, 252-255(Aug 1977). (In German).

From 10. conference on power plant water chemistry; Kecskemet, Hungary (Mar 1977).

The decisive factors influencing the corrosion in water-steam circuits are discussed. Basic theoretical findings and practical experience allow to establish actual criteria for choice of water regime which are given in detail.

10731 Zirconim monobromide, a second double metal sheet structure. Some physical and chemical properties of the metallic zirconium monochloride and monobromide. Daake, R.L.; Corbett, J.D. (Ames Lab., IA). *Inorg. Chem.;* **16**: No. 8, 2029-2033(Aug 1977).

Zirconium monobromide has been synthesized and shown from Guinier x-ray powder diffraction data to contain the same X—Zr—Zr—X slabs of four close-packed layers known in ZrCl but with an alternate packing of the four-layer slabs (ACB rather than ABC); R = 0.16 for 50 hkl reflections; a = 3.5031 (3) and c = 28.071 (3) A for the trigonal cell R3m. HfCl also occurs in the ZrBr structure; a = 3.3697 (3) and c = 26.582 (6) A. The greater hardness of ZrBr, the absence of the graphitelike structural damage which ZrCl exhibits after grinding, and the relative distances in the two structures all appear to be manifestations of significantly stronger interslab binding in ZrBr. This is attributed to the presence of close, second nearest neighbor interactions between Br and Zr layers of the same orientation in adjoining slabs. The metallic character of both phases is clearly established by their x-ray photoelectron spectra, namely, the presence of a substantial density of occupied states at the Fermi level. Attempted intercalation reactions were unsuccessful for both phases.

10732 Core electron binding energies cyclotriphosphazenes and cyclotetraphosphazenes. Avanzino, S.C.; Jolly, W.L.; Schaaf, T.F.; Allcock, H.R. (Univ. of California, Berkeley). *Inorg. Chem.;* **16**: No. 8, 2046-2048(Aug 1977).

The core electron binding energies of $(NPF_2)_3$, $(NPF_2)_4$, $(NPCl_2)_3$, $(NPCl_2)_4$, and $[NP(CH_3)_2]_4$ have been determined in the gas phase by x-ray photoelectron spectroscopy. The data show a reasonable correlation with the elecronegativities of the substituent groups. On going from $(NPF_2)_4$ to $(NPF_2)_3$ or from $(NPCl_2)_4$ to $(NPCl_2)_3$, the binding energies increase by only 0.22 eV or less. This near-constancy of the binding energies suggests that the degree π bonding is similar in the trimers and tetramers.

10733 Crystal absorption spectra for potassium octachlorodimolybdate(II) dihydrate. Fanwick, P.E.; Martin, D.S.; Cotton, F.A.; Webb, T.R. (Ames Lab., IA). *Inorg. Chem.;* **16**: No. 8, 2103-2106(Aug 1977).

Partial polarized crystal spectra are reported for $K_4Mo_2Cl_8$ x $2H_2O$ for both b and c polarization at 300 and 3.7°K. The intense band in the visible region, ca. 19,000 cm^{-1}, has been shown to possess molecular ztoπ polarization. This band was therefore assigned ^{1}Au/sub 2u/ reverse arrow ^{1}A/sub 1g/ (delta* reverse arrow delta). It is sufficiently intense that only the absorption due to a minority fraction could be recorded. At 3.7°K, vibrational structure to the band can be resolved, but there are irregularities in the observed progression. A dipole-allowed but low-intensity transition was observed at 28,800 cm^{-1} with higher intensity in z—π polarization. It has been assigned as the A_2' reverse arrow A_1' component of a ^{3}E/sub u/ reverse arrow ^{1}A/sub 1g/ transition. This is a transition to the triplet state associated with the ^{1}E/sub u/ reverse arrow ^{1}A/sub 1g/ transition seen at 31,400 cm^{-1} in pellet and mull spectra, which was shown to be polarized x, y-sigma. Weak absorptions at 22,000—24,000 cm^{-1} appeared to be vibronic bands.

10734 Temperature and pressure effects on the electronic transitions of nickel(II) complexes with C,C-dimethylethylenediamine and N,N-dimethylethylenediamine. Ferraro, J.R.; Fabbrizzi, L.; Paoletti, P. (Argonne National Lab., IL). *Inorg. Chem.;* **16**: No. 8, 2127-2129(Aug 1977).

The results of the effects of temperature and pressure on the electronic transitions of Ni complexes are tabulated and show that the effects of temperature shift the electronic transition toward lower frequencies. The effects of pressure are opposite in direction and blue shifts occur. (JSR)

10735 Structural studies of precursor and partially oxidized conducting salts. 12. Crystal structure of $Rb_2[Pt(CN)_4](FHF)_{0.40}$. A new lower limit for the platinum—platinum separation and the first anhydrous one-dimensional tetracyanoplatinate complex. Schultz, A.J.; Coffey, C.C.; Lee, G.C.; Williams, J.M. (Argonne National Lab., IL). *Inorg. Chem.;* **16**: No. 8, 2119-2131(Aug 1977).

The synthesis and crystal structure of a new partially oxidized tetracyanoplatinate complex containing the triatomic bifluoride ion $(FHF)^-$ is reported. This complex has the shortest Pt—Pt distance yet observed for any POTCP complex. X-ray data and thermal gravimetric analysis of the Rb salt and its Cs analog showed no evidence for the presence of water; therefore the complexes are believed to be the first anhydrous POTCP complexes. (JSR)

10736 Rare earth metal—metal halide systems. 19. Structural characterization of the reduced holmium chloride Ho_5Cl_{11}. Loechner, U.; Baernighausen, H.; Corbett, J.D. (Univ., Karlsruhe, Ger.). *Inorg. Chem.;* **16**: No. 8, 2134-2135(Aug 1977).

The reduced holmium chloride Ho_5Cl_{11}, with the correct composition $HoCl_{2.20}$, is isomorphous with the monoclinic Dy_5Cl_{11}. The space group is $P2_1/m$. The crystal structure can be considered as a one-dimensional superstructure of the fluorite type built from five basic fluorite units with four additional anions per unit cell. The reason for the relatively large difference between the x-ray stoichiometry 2.20 and the analytical stoichiometry 2.14 found previously is tentatively attributed to contamination by monochloride. (JSR)

10737 Unusual phosphorus basicity of $P(OCH_2CH_2)_3N$ and the molecular structure of $H_3BP(OCH_2CH_2)_3N$. Clardy, J.C.; Milbrath, D.S.; Verkade, J.G. (Ames Lab., IA). *Inorg. Chem.;* **16**: No. 8, 2135-2137(Aug 1977).

Spectral and chemical studies made on the borane $H_3BP(OCH_2CH_2)_3N$ do not permit a clear conclusion to be drawn regarding the question of a tricyclic vs. a bicyclic structure. It is also shown that the unusual basicity of $P(OCH_2CH_2)_3N$ in the borane is not the result of the formation of a P reverse arrow N transannular bond. (JSR)

10738 Process for making calcium chromate. Dillard, B.M.; Welbon, W.W. (to Energy Research and Development Administration). US Patent 4,029,735. 14 Jun 1977. Filed date 9 Oct 1975. 4p. PAT-APPL-621,000.

Ammonium chromate is contacted with calcium hydroxide to form calcium chromate. 1 claim, 1 figure.

10739 Agglomeration 77. Volume 1. Sastry, K.V.S. (ed.). New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1977). 522p. (CONF-770312—P1).

From Annual AIME meeting; Atlanta, Georgia, USA (Mar 1977).

The development of agglomeration processing of iron ore concentrates is considered to be the single most important advancement in the mineral industry in recent years as measured by the tons of ore treated and capital investment. "The first attempt to bind together the art of agglomeration on a broad international plane; providing cross-pollination of thinking and doing" was the theme for the First International Symposium on Agglomeration held in Philadelphia, Pennsylvania in April 1961. Since the time of the first symposium, the scope of agglomeration has expanded considerably beyond the treating of magnetic iron ore concentrates into the processing of a wide variety of particulate materials. New technologies have been developed for the processing of these feed materials and for the production of agglomerates with stringent quality requirements. The Second International Symposium on Agglomeration has been undertaken to document recent progress and state of the art of agglomerating particulate materials. This proceedings volume includes papers on the application of such methods of agglomeration as briquetting, sintering, and pelletizing to the mineral, ceramic, chemical, fertilizer, and other industries. These papers present theoretical backgrounds, testing methods, operating experiences, design, control, and cost considerations of the unit operation of agglomeration. No papers were entered individually.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 9778

10740 (LA-UR—77-2222) **High-resolution spectroscopy using tunable diode lasers: techniques and applications.** McDowell, R.S. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 9p. (CONF-771040—5). Dep. NTIS, PC A02/MF A01.

From Electro-Optical systems conference; Anaheim, California, USA (25 Oct 1977).

Methods for generating tunable monochromatic infrared radiation are tabulated. Techniques used in tunable semiconductor diode laser spectroscopy are discussed. Spectra of SF_6 and OsO_4 are discussed, including references to photodissociation and laser isotope separation. 4 figures, 3 tables, 80 references. (DLC)

10741 Separation of osmium isotopes by dissociation of the OsO_4 molecule in a two-frequency infrared laser field. Ambartsumyan, R.V.; Gorokhov, Y.A.; Makarov, G.N.; Puretskii, A.A.; Furzikov, N.P. (Institute of Spectroscopy, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **7**: No. 7, 904-905(Jul 1977).

A report is given of the separation of osmium isotopes by the method of selective dissociation of the OsO_4 molecule in a two-frequency infrared laser field. It is shown that the dissociation selectivity can be considerably higher than in the case of a strong single-frequency field. Possibilities of further increase in the dissociation selectivity are considered.

ORGANIC CHEMISTRY

10742 (CONF-770814—8) **Oxidative degradation studies of coal and solvent refined coal.** Hayatsu, R.; Winans, R.E.; Scott, R.G.; Moore, L.P.; Studier, M.H. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 13p. Dep. NTIS, PC A02/MF A01.

From American Chemical Society meeting; Chicago, Illinois, USA (29 Aug 1977).

The bulk of the organic matter in coals consists of a macromolecular material of complex and variable composition. To date a number of oxidizing agents have been used. Among these were HNO_3, HNO_3-$K_2Cr_2O_7$, $KMnO_4$, O_2, H_2O_2-O_3 and NaOCl, all drastic oxidants. Because these reagents produce extensive ring degradations, with benzene carboxylic acids being the only aromatic compounds identified, they have been of limited usefulness. These products from drastic oxidants were compared with those from more selective oxidants designed to break up the macromolecules with a minimum of chemical change so that units indigenous to coals can be identified. Aqueous $Na_2Cr_2O_7$ was found to be selective and a number of polynuclear aromatic units that resulted from the dichromate oxidation of a bituminous coal and which are probably indigenous to the coal were reported. In addition to four coals, a solvent-refined coal and two completely abiotic samples, a synthetic Fischer-Tropsch polymer, and a polymer from the Murchison meteorite were used for comparison and to test the oxidation methods. Sodium dichromate oxidizes side chains and alicylic appendages to polynuclear aromatic systems with a minimum degradation of aromatic rings. The fact that no polynuclear aromatic compounds with more than two fused rings were detected in the oxidation products of lignite and that the degree of condensation increases with rank of coal is internally consistent and suggests that condensation during oxidation with $Na_2Cr_2O_7$ is minimal.

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 10728, 10734, 10737

10743 (UCLA—34P218X3) **Multiheteromacrocycles that complex metal ions. Third progress report, 1 May 1976—30 April 1977.** Cram, D.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Jan 1977. Contract EY-76-S-03-0034-218. 34p. Dep. NTIS, PC A03/MF A01.

The overall objective of this research is to design, synthesize and evaluate cyclic and polycyclic host organic compounds for their abilities to complex and lipophilize guest metal ions, their complexes and clusters. Host organic compounds consist of strategically placed solvating, coordinating and ion-pairing sites tied together by covalent bonds through hydrocarbon units around cavities shaped to be occupied by guest metal ions, or metal ions plus their ligands. Specificity in complexation is sought by matching the following properties of host and guest: cavity and metal ion sizes; geometric arrangements of binding sites; numbers of binding sites; characters of binding sites; and valences. The specific compounds synthesized and their complexing and lipophilizing properties are summarized.

ISOTOPE EFFECTS

10744 (COO—2192-23) **Electronic relaxation processes in polyatomic molecules. Progress report, October 1, 1976—September 31, 1977.** Lim, E.C. (Wayne State Univ., Detroit, Mich. (USA)). Sep 1977. Contract EY-76-S-02-2192. 10p. Dep. NTIS, PC A02/MF A01.

Experimental and theoretical studies of isotope and substituent effects on T_1 radiationless decay rates have been carried out as a test of the working hypothesis that vibronic coupling between $n\pi^*$ and $\pi\pi^*$ states lead to very efficient radiationless decay from the lower of the two vibronically coupled pair (proximity effect). In addition to providing general support to this hypothesis, the results indicate that isotope effects on spin sublevel decay rates are needed for a stringent test of the proximity effect. The radiationless decay rates of the ^{3}B/sub 1g/ state of anthracene and its derivatives have been deduced from the quantum yield of ^{3}B/sub 1g/ → ^{3}B/sub 2u/ (T_1) fluorescence and the oscillator strength of ^{3}B/sub 1g/ → ^{3}B/sub 2u/ absorption. The results suggest that there is a hitherto unrecognized triplet state (probably a ^{3}B/sub 3u/) slightly below the ^{3}B/sub 1g/, which has long been thought to be the second triplet state of the molecules. Very fast ^{3}B/sub 1g/ → ^{3}B/sub 3u/ internal conversion, over a small energy gap, is proposed to "drive" intersystem crossing from the ^{1}B/sub 2u/(S_1) state to the triplet manifold via a resonance mechanism. This proposal has important bearing on the understanding of the mechanisms for singlet → triplet intersystem crossing in aromatic hydrocarbons.

ELECTROCHEMISTRY

10745 **Extended abstracts.** Princeton, NJ; Electrochemical Society (1976). 938p. (CONF-761057—(Absts.)).

From Electrochemical Society meeting; Las Vegas, Nevada, USA (17 Oct 1976).

360 "extended" abstracts of papers presented at the Fall Meeting of the Electrochemical Society, Las Vegas, Nevada, October 17-22, 1976, are given. The Battery, Corrosion, Dielectrics and Insulation, Electrodeposition, Electronics, Electrothermics and Metallurgy, and Industrial Electrolytic Divisions took part. (RWR)

RADIATION CHEMISTRY

10746 (ORO—3781-14) **Radiation chemistry of plastic crystals. Annual progress report, November 1, 1976—October 31, 1977.** Klingen, T.J. (Mississippi Univ., University (USA). Dept. of Chemistry). 1 Nov 1977. Contract EY-76-S-05-3781. 60p. Dep. NTIS, PC A04/MF A01.

The overall purpose of this investigation is the understanding of the role that mesomorphism plays in the radiation chemistry of plastic crystals. In approaching this problem, the first step is to obtain data on the basic radiation chemistry of the most ordered solid state—the crystalline state. Thus, the results reported here are concerned with determination of the radiolysis of three plastic crystals in their highest ordered state. In addition to these studies, investigation of the optical properties and the positron life time properties of these materials in their plastic crystalline state was undertaken. The primary purpose of these studies during the current reporting period was the determination of the feasibility of these techniques to provide useful information to the overall project goal.

10747 **Studies on the formation of volatile amines from trimethylamine oxide by gamma-irradiation, (1). Determination of ammonia and volatile amines.** Uchiyama, S.; Kondo, T.; Uchiyama, M. (National Inst. of Hygienic Sciences, Tokyo (Japan)). *Shokuhin Eiseigaku Zasshi;* **17**: No. 5, 345-351(Oct 1976). (In Japanese).

The simplified method for determination of ammonia and volatile amines, especially methylamines formed from trimethylamine oxide (TMAO) by gamma-irradiation, was established. The method involved the extraction procedure by means of Conway's micro diffusion apparatus and the determination by TLC-fluorodensitometry of DNS-derivatives as well as by gas-liquid chromatography. The satisfactory quantitative results were obtained using ammonia, monomethylamine and dimethylamine in the concentration of 1×10^{-7} - 3×10^{-6} mol/ml and trimethylamine in the concentration of 8×10^{-8} - 1×10^{-5} mol/ml.

10748 **Studies on the formation of volatile amines from trimethylamine oxide by gamma-irradiation. I. Influence of co-existing metal ions and protein.** Uchiyama, S.; Kondo, T.; Uchiyama, M. (National Inst. of Hygienic Sciences, Tokyo (Japan)). *Shokuhin Eiseigaku Zasshi;* **17**: No. 5, 352-356(Oct 1976). (In Japanese).

The fundamental investigation concerning the formation of volatile amines from trimethylamine oxide (TMAO) by gamma-irradiation was carried out as a model of the irradiation of fish-meat products like Kamaboko. By the irradiation of 5.8 Mrad, 5×10^{-6} mol of dimethylamine (DMA) was produced from 1×10^{-4} mol of TMAO in a phosphate buffer (pH 6.5). Fe^{2+}, Fe^{3+}, Zn^{2+} and Al^{3+} promoted the formation of amines but Ca^{2+}, Mg^{2+} and Na^+ scarcely affected it. On the other hand, cysteine, which is known as a protecting agent against gamma-ray, promoted the formation of DMA. However, protein worked repressibly for amine formation even when Fe^{3+} was contained.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

REFER ALSO TO CITATION(S) 11143

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 10724

10749 (ORO—4447-061) **First preparation of an einsteinium(II) compound, $EsCl_2$.** Fellows, R.L.; Peterson, J.R.; Young, J.P.; Haire, R.G. (Tennessee Univ., Knoxville (USA). Dept. of Chemistry; Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 8p. (CONF-771039—2). Dep. NTIS, PC A02/MF A01.

From 13. rare earth research conference; Olgebay Park, West Virginia, USA (16 Oct 1977).

This paper reports the preparation of Es(II) in $LnCl_2$ matrices and of bulk $EsCl_2$, and the absorption spectrum of Es(II) in the visible—near ir region. (DLC)

10750 (ZfK—316) **Calculation and discussion of state diagrams in the system Pu-F-O-H.** Gruenberg, H. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)). Oct 1976. 13p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

In the system Pu-F-O-H state diagrams at a pressure of reacting gases of 1 atm have been calculated and discussed together with state diagrams of the system U-F-O-H. Conclusions are drawn for the separation of uranium and plutonium and about the conversion of fluorides of uranium and plutonium to the oxides.

10751 Crystal structure of tetrakis[bis(N,N'-dimethylethylenediamido)uranium(IV)], a tetrameric globular complex. Reynolds, J.G.; Zalkin, A.; Templeton, D.H.; Edelstein, N.M. (Univ. of California, Berkeley). *Inorg. Chem.;* **16**: No. 8, 1858-1861(Aug 1977).

The tetrameric compound $U_4(CH_3NCH_2CH_2NCH_3)_8$ is a minor product of the reaction of tetrakis(diethylamido)uranium(IV) with dimethylethylenediamine in pentane. The crystals are orthorhombic, space group Fddd, with a = 12.02 (2) A, b = 22.73 (4) A, and c = 34.32 (6) A; d/sub calcd/ = 2.32 g/cm^3 for Z = 8. X-ray diffraction intensity data were collected by an automated diffractometer using graphite-monochromated Mo Kα radiation. For 399 reflections with F^2 greater than 2 sigma, R_1 = 0.078 and R_2 = 0.060. Four bis[N,N'-dimethylethylenediamido]uranium(IV) units are connected by bridging nitrogen atoms to form a closed tetrameric complex in which the four uranium atoms are 3.6 A apart at the corners of a twisted square. Each uranium atom is bonded to six nitrogen atoms in a highly distorted trigonal prism. Attached to each uranium atom are two nitrogen atoms from a nonbridging dimethylethylenediamido ligand and four from two bridging ligands.

COMBUSTION CHEMISTRY

REFER ALSO TO CITATION(S) 9857

ENGINEERING

10752 (CONF-7605161—) **Engineering, 1976—2001.** (Institution of Engineers, Sydney (Australia)). 1976. 431p. of Engineers, Sydney, Australia.

From Annual engineering conference; Townsville, Australia (10 May 1976).

Abstracts were prepared for 20 of the 69 papers presented, six of these papers being published separately. (MCW)

GENERAL ENGINEERING

10753 (SAND—77-0587) **Surface roughness effects on the hypersonic turbulent boundary layer.** Berg, D.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1977. Contract EY-76-C-04-0789. 113p. Dep. NTIS, PC A06/MF A01.

An experimental investigation of the response of a hypersonic turbulent boundary layer to a step change in surface roughness has been performed. The boundary layer on a flat nozzle wall of a Mach 6 wind tunnel was subjected to abrupt changes in surface roughness and its adjustment to the new surface conditions was examined. Both mean and fluctuating flow properties were acquired for smooth-to-rough and rough-to-smooth surface configurations. The boundary layer was found to respond gradually and to attain new equilibrium profiles, for both the mean and the fluctuating properties, some 10 to 25 delta downstream of the step change. Mean flow self-similarity was the first to establish itself, followed by the mass flux fluctuations, followed in turn by the total temperature fluctuations. Use of a modified Van Driest transformation resulted in good correlations of smooth and rough wall data in the form of the incompressible law of the wall. This is true even in the nonequilibrium vicinity of the step for small roughness heights. The present data are found to correlate well with previously published roughness effect data from low and high speed flows when the roughnesses are characterized by an equivalent sand grain roughness height.

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 9596, 9850, 10200

10754 (LA—6995-MS) **Los Alamos Scientific Laboratory building cost index.** Lemon, G.D.; Morris, D.W.; McConnell, P.H. (Los Alamos Scientific Lab., N.Mex. (USA)). Nov 1977. Contract W-7405-ENG-36. 6p. Dep. NTIS, PC A02/MF A01.

The Controller's budget request for FY-1979 established guidance for escalation rates at 6 to 8 percent for construction projects beyond FY-1976. The Los Alamos Scientific Laboratory (LASL) has chosen to use an annual construction escalation rate of 10 percent. Results of this study should contribute toward the establishment of realistic construction cost estimate totals and estimates of annual construction funding requirements. Many methods were used to arrive at the LASL escalation rate recommendation. First, a computer program was developed which greatly expanded the number of materials previously analyzed. The program calculated the 1970 to 76 weighted averages for labor, materials, and equipment for the base line project. It also plotted graphs for each category and composite indexes for labor and material/equipment. Second, estimated increases for 1977 were obtained from several sources. The Zia Company provided labor cost estimates. Projected increases for material and equipment were obtained through conversations with vendors and analysis of trade publications. Third, economic forecast reports and the Wall Street Journal were used for source material, narrative, and forecast support. Finally, we compared LASL Building Cost Index with the effects of escalation associated with three recently developed projects at LASL.

10755 (ORNL/SUB—3706/3) **General description of the finite-element method of analysis in engineering mechanics.** Hovland, H.; Russell, J.E. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Office of Waste Isolation). 5 Oct 1977. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

The finite-element method is a numerical technique of analysis in engineering mechanics, and has been developed simultaneously with the increasing use of high-speed electronic digital computers. For many engineering problems in real life, it is not possible to obtain an analytical solution. An analytical solution is a mathematical expression that gives the values of an unknown desired quantity at any location in a body in relation to the material behavior and prescribed boundary and/or initial conditions. In general, analytical solutions can only be obtained for simplified problems, notably of the linear class. When a problem involves temperature- and/or stress-dependent material properties, nonlinear deformations and complex boundary conditions, one is forced to make use of a computerized solution scheme in order to obtain the proper values of the unknowns at given discrete points in the continuum or body. The primary advantage of employing the finite-element method to determine the stress and strain distributions in a continuum is that the method can be systematically programmed to accommodate such difficulties as nonhomogeneous materials, nonlinear stress-strain behavior, time and thermal effects, and complex boundary conditions.

10756 (RFP—2482) **Statistical tests for locating power in a Fourier line spectrum.** Dixon, R.D.; Geoffrey, J.R. (Atomics International Div., Golden, Colo. (USA). Rocky Flats Plant). 27 Jul 1977. Contract EY-76-C-04-3533. 12p. Dep. NTIS, PC A02/MF A01.

Fourier line spectra are used to detect noise on the electron beam of an electron beam welder. These spectra are calculated from data in the form of x-ray intensity as a function of time. Statistical tests are described that provide a means of determining the presence of random and periodic signals. The tests remove the uncertainty in deciding if power is present and, if so, at which frequencies. The tests have proven to be consistent and reliable. They are of suitable generality to be useful when it is essential to assess a signal for power quantitatively.

10757 Combination spindle-drive system for high precision machining. Gerth, H.L. (to Energy Research and Development Administration). US Patent 4,037,496. 26 Jul 1977. Filed date 1 Sep 1976. 4p.

PAT-APPL-719,637.

A combination spindle-drive is provided for fabrication of optical quality surface finishes. Both the spindle-and-drive utilize the spindle bearings for support, thereby removing the conventional drive-means bearings as a source of vibration. An airbearing spindle is modified to carry at the drive end a highly conductive cup-shaped rotor which is aligned with a stationary stator to produce torque in the cup-shaped rotor through the reaction of eddy currents induced in the rotor. This arrangement eliminates magnetic attraction forces and all force is in the form of torque on the cup-shaped rotor.

10758 Nonferromagnetic linear variable differential transormer. Ellis, J.F.; Walstrom, P.L. (to Energy Research and Development Administration). US Patent 4,030,085. 14 Jun 1977. Filed date 20 Jul 1976. 4p.

PAT-APPL-707,000.

A nonferromagnetic linear variable differential transformer for accurately measuring mechanical displacements in the presence of high magnetic fields is provided. The device utilizes a movable primary coil inside a fixed secondary coil that consists of two series-opposed windings. Operation is such that the secondary output voltage is maintained in phase (depending on polarity) with the primary voltage. The transducer is well-suited to long cable runs and

is useful for measuring small displacements in the presence of high or alternating magnetic fields.

10759 Tool setting device. Brown, R.J. (to Energy Research and Development Administration). US Patent 4,016,784. 12 Apr 1977. Filed date 5 Jan 1976. 4p.
PAT-APPL-646,705.

The present invention relates to a tool setting device for use with numerically controlled machine tools, such as lathes and milling machines. A reference position of the machine tool relative to the workpiece along both the X and Y axes is utilized by the control circuit for driving the tool through its program. This reference position is determined for both axes by displacing a single linear variable displacement transducer (LVDT) with the machine tool through a T-shaped pivotal bar. The use of the T-shaped bar allows the cutting tool to be moved sequentially in the X or Y direction for indicating the actual position of the machine tool relative to the predetermined desired position in the numerical control circuit by using a single LVDT.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 10075, 10076, 10870, 10873, 11308, 11310, 11347

10760 Flow control device for superconductive rotor refrigerant. Pomeroy, B.D.; Kosky, P.G. (to General Electric Co.). US Patent 4,048,529. 13 Sep 1977. Filed date 26 Nov 1975. 6p.

Cryogenic liquid for cooling the rotor of a superconducting generator enters the rotor along the inner surface of a centrally-disposed rotating conduit extending into the rotor. From the resulting annulus of liquid coolant surrounding a vapor core, liquid coolant flows via a pair of liquid-delivery ducts to the surface of the pool of coolant bathing the rotor windings. Each delivery duct comprises a radially-extending receiving tube and a radially-extending delivery tube interconnected by a over-flow trap. The outer end of the delivery tube is in flow communication with the vapor in the central core of the rotor winding chamber and the inner end of the receiving tube is in flow communication with both the liquid coolant and the vapor core in the rotating conduit.

10761 (UCID—17597) **Electric and magnetic sensing systems: applications.** Chilton, F.; Wood, L.; Buntzen, R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1977. Contract W-7405-ENG-48. 42p. Dep. NTIS, PC A03/MF A01.

The objective of this lecture is to review the underlying principles of electric and magnetic sensing, to discuss some of the more recent advances in the associated technologies and to provide some insight into the use of such systems in ocean surveillance. A primary application of electric and magnetic sensors are the surveillance activities of the U.S. Navy. This application suite first became possible because of extensive pre-World War II development work by the Gulf Oil Company, in search of new oil fields. Magnetic detection became a Navy capability in 1941 as the result of this industrial development work. Detection activity support remains the primary thrust of electric and magnetic technology development within the U.S. Navy today. Extremely sensitive devices such as superconducting quantum interference devices (SQUIDS) represent the single most important new basic physical principle involved. Such technology plus signal processing and systems engineering gains have expanded and refined the detector application parameter space. For example, magnetic gradient measurements of the saline (and therefore electrically conducting) flow associated with surface and internal ocean waves are being considered. Such measurements are important to development of technologies for both acoustic and non-acoustic ASW. In many system concepts, signal-to-noise ratios and false-alarm rates depend on both temporal and spatial distributions of the ocean natural wave background. If magnetic measurements of acceptable quality can be made by aircraft, high-sweep-rate mapping of the surface and internal wave spectra of an entire ocean basic could be seriously contemplated.

10762 Superconductive bolometers for submillimeter wavelengths. Clarke, J.; Hoffer, G.I.; Richards, P.L.; Yeh, N.h. (Department of Physics, University of California, Berkeley, California 94720). *J. Appl. Phys.;* **48**: No. 12, 4865-4879(Dec 1977).

Three types of composite superconductive bolometers are described in which the temperature-sensitive element is a superconducting film at the transition temperature, a superconductor—normal metal—superconductor Josephson junction, or a superconductor—insulator—normal metal quasiparticle tunneling junction. The temperature-sensitive element is evaporated onto a sapphire substrate on the reverse side of which is a bismuth film to absorb the submillimeter radiation. The noise limitations of each type of bolometer are calculated. The fabrication and measured performance of the transition-edge bolometer and the Josephson-junction bolometer are described. The best electrical (noise-equivalent power) NEP obtained with a transition-edge bolometer fabricated on a 4 x 4 x 0.005-mm sapphire substrate is (1.7 +- 0.1) x 10^{-15} W Hz/sup -1/2/ at 2 Hz at an operating temperature of 1.27 K. This NEP is within a factor of 2 of the thermal noise limit. The effective absorptivity of the bismuth film is measured to be 0.47 +- 0.05, and the corresponding detectivity D^* is calculated to be (1.1 +- 0.1) x 10^{14} cm W^{-1} Hz/sup 1/2/. Suggestions are made for further improvements in sensitivity.

10763 Power spectrum of radiation from a Josephson junction. Likes, R.S.; Falco, C.M. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.;* **48**: No. 12, 5370-5371(Dec 1977).

The harmonic content of the power generated by a Josephson junction is calculated as a function of the applied current. The effect of the pair-quasiparticle interference conductivity is considered, and the limiting form of the power is derived for large driving currents.

PROTECTIVE STRUCTURES AND EQUIPMENT

REFER ALSO TO CITATION(S) 10345

10764 (LA—6999-PR) **Ventilation systems analysis during tornado conditions. Progress report, October 1, 1976—April 30, 1977.** Gregory, W.S.; Andrae, R.W.; Duerre, K.H.; Dove, R.C. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1977. Contract W-7405-ENG-36. 32p. Dep. NTIS, PC A03/MF A01.

A computer code, TVENT, has been developed to predict the tornado-induced pressures and flows within an arbitrary nuclear facility ventilation system. Operational experience with TVENT in analyzing an ERDA facility has resulted in code modifications. Several architectural firms have agreed to use TVENT to analyze their designs. They will provide us with comments on the code and user's manual to make them more useful. Our investigation of the feasibility of scale model analysis to provide additional comparative data and preliminary results is presented. Preliminary calculations indicate that a distorted model would be necessary. Distortion of the Reynolds number relating the model to the prototype appears to be the most practical approach. The Idaho Chemical Processing Plant (ICPP) atmospheric protection system was analyzed using TVENT, and the results are presented. They were found to be in close agreement with the real system under steady-state conditions. For a tornado at the exhaust stack, TVENT predicted a flow increase of 70 percent through the system's HEPA filters.

10765 Filter material charging apparatus for filter assembly for radioactive contaminants. Goldsmith, J.M.; O'Nan, A. Jr. (to American Air Filter Co., Inc.). US Patent 4,049,405. 20 Sep 1977. Filed date 26 Sep 1975. 4p.

A filter charging apparatus for a filter assembly is described. The filter assembly includes a housing with at least one filter bed therein and the filter charging apparatus for adding filter material to the filter assembly includes a tank with an opening therein, the tank opening being disposed in flow communication with opposed first and second conduit means, the first conduit means being in flow communication with the filter assembly housing and the second conduit means being in flow communication with a blower means. Upon activation of the blower means, the blower means pneumatically conveys the filter material from the tank to the filter housing.

HANDLING EQUIPMENT AND PROCEDURES

10766 (ORNL/TM—5971) **ORNL shielded facilities capable of remote handling of highly radioactive beta—gamma emitting materials.** Whitson, W.R. (Oak Ridge National Lab., Tenn. (USA)). Sep 1977. Contract W-7405-ENG-26. 43p. Dep. NTIS, PC A03/MF A01.

A survey of ORNL facilities having adequate shielding and containment for the remote handling of experimental quantities of highly radioactive beta-gamma emitting materials is summarized. Portions of the detailed descriptions of these facilities previously published in ORNL/TM-1268 are still valid and are repeated.

SHIPPING CONTAINERS

10767 (ORNL/ENG/TM—10) **Safety analysis report for packaging: the ORNL in-pile capsule shipping cask.** Evans, J.H.; Chipley, K.K.; Haynie, C.B.; Crowley, W.K.; Just, R.A. (Oak Ridge National Lab., Tenn. (USA)). Nov 1977. Contract W-7405-ENG-26. 200p. Dep. NTIS, PC A10/MF A01.

The ORNL in-pile capsule shipping cask is used to transport irradiated experimental capsules and spent fuel elements. The cask was analytically evaluated to determine its compliance with the applicable regulations governing containers in which radioactive materials are transported. Computational procedures were used to determine the structural integrity and thermal behavior of the cask relative to the general standards for normal conditions of transport and the standards for the hypothetical accident conditions. The results of the evaluation show that the cask is in compliance with the applicable regulations.

10768 (ORNL/ENG/TM—11) **Safety analysis report for packaging: the ORNL loop transport cask.** Evans, J.H.; Chipley, K.K.; Nelms, H.A.; Crowley, W.K.; Just, R.A. (Oak Ridge National Lab., Tenn. (USA)). Nov 1977. Contract W-7405-ENG-26. 222p. Dep. NTIS, PC A11/MF A01.

An evaluation of the ORNL loop transport cask demonstrating its compliance with the regulations governing the transportation of radioactive and fissile materials is presented. A previous review of the cask is updated to demonstrate compliance with current regulations, to present current procedures, and to reflect the more recent technology.

10769 (ORNL/ENG/TM—12) **Safety analysis report for packaging: the ORNL HFIR spent-fuel-element shipping cask.** Evans, J.H.; Chipley, K.K.; Eversole, R.E.; Just, R.A.; Llewellyn, G.H. (Oak Ridge National Lab., Tenn. (USA)). Nov 1977. Contract W-7405-ENG-26. 238p. Dep. NTIS, PC A12/MF A01.

The Oak Ridge National Laboratory High Flux Isotope Reactor (HFIR) spent-fuel-element shipping cask is used to transport HFIR, Oak Ridge Research Reactor (ORR), and other reactor fuel elements. The cask was analytically evaluated to determine its compliance with the applicable regulations governing containers in which radioactive materials are transported. Computational procedures and tests were used to determine behavior of the cask relative to the general standards for the hypothetical accident conditions. The results of the evaluation show that the cask is in compliance with the applicable regulations.

10770 (ORNL/TM—1312(Vol.17)) **Obsolete cask program: oblique and center-of-gravity drop tests.** Shappert, L.B.; Bradley, N.C.; Bryan, W.L.; Chipley, K.K.; Evans, J.H.; Seagren, R.D.; Box, W.D. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 57p. Dep. NTIS, PC A04/MF A01.

The Heavy-Water Component Test Reactor cask was subjected to two impact tests that involved 9-m drops onto a solid, essentially unyielding surface. The cask, weighing about 21,000 kg, was dropped at an oblique angle to the pad (the longitudinal axis at an angle of 30° from the horizontal). The cask was later dropped at an angle (11° from the vertical) so that the center of gravity was directly over the point of impact. The hoisting equipment at the Tower Shielding Facility (TSF) was used to make the drops. Deformation of the cask and accelerations at several points were predicted, and values were compared with test results obtained from an extensive instrumentation system. Predicted cask deformations agreed reasonably well with the measured values.

10771 (SAND—76-0557) **Evaluation of nonlinear finite element computer programs for the static structural analysis of large shipping containers.** Benzley, S.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1977. Contract EY-76-C-04-0789. 41p. Dep. NTIS, PC A03/MF A01.

The ability to properly analyze the static structural response of very large shipping containers with nonlinear finite element computer programs is assessed. Results and capabilities of several computer programs are compared. (TFD)

10772 (UCRL—80122) **Design and testing of a new multipurpose tritium shipping package.** Sandberg, R.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Sep 1977. Contract W-7405-ENG-48. 5p. (CONF-770595—1). Dep. NTIS, PC A02/MF A01.

From DAMSUL committee meeting; Las Vegas, Nevada, USA (18 May 1977).

A new multipurpose tritium shipping container has been designed and tested at the Lawrence Livermore Laboratory. This new package, the model UC-609, is different from existing packages in that the shipping package itself provides the primary tritium containment boundary. In contrast, the packages currently in use rely solely upon the interior storage vessel (vessel into which tritium was loaded) for containment with the shipping package acting only as physical protection for that vessel. All shipping packages for radioactive materials require a complete design verification and review by ERDA before they can be used. With the currently used shipping packages, a separate analysis must be made for each storage vessel that is to be shipped. The great amount of time and work involved in obtaining an ERDA approval greatly inhibits the implementation of new storage vessel designs. After an ERDA approval is acquired for the UC-609 package, any storage vessel that falls within the following limitation can be shipped: maximum storage vessel weight—100 lbs; maximum storage vessel size—10 in. dia x 30 in. long; and maximum contents of vessel—30 moles of gas not more than 25 moles of which may be tritium.

TRANSPORT AND STORAGE FACILITIES

10773 **Influence of weight distribution on rolling of an LNG carrier.** Gie, T.S.; Minkenberg, H.L. (Netherlands Ship Model Basin, Wageningen). *Ocean Eng.;* 4: No. 1, 1-13(Mar 1977).

The various effects of the weight distribution on the roll motion of an LNG carrier based upon model tests results are discussed. The tests consisted of extinction tests in calm water as well as roll response tests in regular beam waves. The results of the wave tests were compared with those calculated with the much used simplified equation for pure rolling.

MINING AND DRILLING EQUIPMENT AND FACILITIES

10774 **Apparatus and process for drilling underground arcuate paths utilizing directional drill and following liner.** Cherrington, M.D. (to Tidril Corp.). US Patent 4,051,911. 4 Oct 1977. Filed date 11 Jun 1976. 6p.

A motor-powered directional drill is advanced in an inverted arcuate path underneath an obstacle such as a water course. A second concentric and larger lining pipe follows the advance of the directional drill either simultaneously but preferably sequentially to form a concentric annulus about the directional drill. This lining pipe preserves the directional drilling path made and prevents the collapse or the erosion of the hole due to manipulation of the directional drill. When the inverted path underneath the obstacle is completed and the liner extends the full length, the liner becomes a large diameter pipe of improved tortional capability which can be used subsequently to ream the hole to full size for placement of a production casing. A specialized drilling rig is provided having one advancing chuck for crowding the directional drill into the ground and another larger rotating chuck to rotate and advance the following lining pipe into the ground concentrically about the directional drill.

10775 **Two way earth boring fluid motor.** Clark, W. US Patent 4,051,910. 4 Oct 1977. Filed date 8 Dec 1975. 8p.

A fluid motor is described that is composed of a helical gear pair wherein an inner chamber has an external helical thread and a cooperating outer member has one more internal helical thread than the number of external helical threads on the inner member. The outer member is secured to one of the sections of a water swivel which is conventional except that it has an axial intake, radial tube and inner member supporting guide, and means are associated with an end of the inner member and with the other section of the water swivel to prevent relative rotation between said inner and outer members while permitting gyration of the inner member in relation to the outer member. Each end of the device has a tapered female thread. The motor may be used either end up. A drill pipe or suitable sub is threaded into one end of the device and a tool is threaded into the other end of the device, directly or with the sub between. In one embodiment the outer member of the gear pair is held stationary by the drill pipe which is threaded into it or with a sub between, and the tool which is threaded into the other end is rotated by the rotation of the inner member and the rotating part of the water swivel. In another embodiment, the drill pipe is threaded into the stationary part of the water swivel or with a sub between and thus the inner element of the gear pair is held stationary and the outer element is caused to rotate with the rotating portion of the water swivel, and thus the tool is driven by the outer element of the gear pair. The tool is useful in earth boring as in well drilling, coring, mining, foundation settings, and substrata exploration.

10776 **Turbine drill for drilling at great depths.** Baum, W. (to P.E.I. Inc.). US Patent 4,051,909. 4 Oct 1977. Filed date 22 Nov 1976. 12p.

A drilling device is disclosed which comprises a tubular drilling lance adapted to being lowered to great depths in the earth's surface and being raised therefrom. Disposed within the drilling lance is an energy generating system which comprises a fluid vaporizing system and a turbine coupled to the vaporizing system by a closed fluid circuit. Coupled to the turbine and extending outwardly from the drilling lance is a drill bit. The drilling device is configured such that vaporized fluid activates the turbine, which in turn makes the drill bit operable.

10777 **Downhole drilling system.** Driver, W.B. US Patent 4,051,908. 4 Oct 1977. Filed date 5 Nov 1976. 6p.

According to the invention an improved system for the drilling of small holes from and at right angles to a vertical well hole is described. The system is directed by a ninety degree elbow attached to the downhole end of a small diameter tube section. The uphole end of the tube section is attached to the downhole end of a large diameter tubing string. A downhole electrical motor operates the drilling part of the system from inside the large diameter tubing string. The drive part of the system which operates the drill bit consists of a pump, which also provides drilling fluids to the drill bit, a small diameter drill pipe, a flexible drill pipe which operates the drill bit from around the ninety degree elbow. An electrical mechanical cable provides power to the electrical motor and hoists the electrical motor and its attachments in and out of the tubing string. An anti-torque mechanism attached to the uphole end of the electrical motor holds the electrical motor in place when the electrical motor is in operation.

10778 **Method and apparatus for supporting a mine roof.** Koval, S.F. US Patent 4,051,683. 4 Oct 1977. Filed date 28 Jun 1976. 12p.

A reinforcing rod having a threaded end portion with a coupling secured thereto is inserted in a drill hole of a rock formation, such as a mine roof, with the threaded end adjacent the emergent end of the drill hole and the opposite end in contact with cartridges containing a resinous composition positioned within the drill hole. A bolt having a threaded end portion is engaged to the coupling. A roof plate is retained on the opposite end of the bolt extending from the drill hole. A shear pin is positioned transversely in the coupling and maintains the adjacent end portions of the rod and the bolt in spaced relation to permit rotation of the connected rod and bolt in the drill hole to fracture the resin cartridges. Contact of the threaded end of the bolt with the shear pin maintains the roof plate spaced from the face of the rock formation as the resin is mixed and allowed to cure to adhesively bond the rod to the rock formation. With the rod anchored to the rock formation further rotation of the bolt advances the bolt through the coupling to shear the pin and urge the roof plate into abutting relation with the rock face. Continued rotation of the bolt tensions the bolt and compresses the rock strata to provide a reinforced rock formation.

10779 **Well tool.** Crickmer, C.D. (to Otis Engineering Corp.). US Patent 4,047,565. 13 Sep 1977. Filed date 29 Mar 1976. 10p.

A well tool and more particularly a hanger assembly having an improved design for more effectively, reliably and economically hanging a liner or other well equipment in a well casing or the like is described.

10780 **Impact drilling tool.** Harris, J.W.; Bassinger, R.; Bassinger, G. (to Bassinger Tool Enterprises, Ltd.). US Patent 4,044,844. 30 Aug 1977. Filed date 19 Jul 1976. 8p.

A fluid operated impact drilling tool has a hammer slidably mounted in a casing connected to a string of drilling pipe. Inside the casing above the hammer is mounted a valve. Both the valve and hammer have reciprocal sliding movement along the longitudinal axis of the tool to substantially interrupt flow of a drilling fluid therethrough. Movement of the valve and hammer predominantly results from different pressures acting on separate pressure areas of the valve and hammer. The hammer may impact either an anvil or a bit attached thereto. Wear on the valve and hammer is reduced by smooth, hardened surfaces at locations subject to wear. A trapped fluid may also be used in an alternative embodiment to dampen the shock effect of the valve as it reaches its upper and lower stops.

10781 **Hydroxy-aluminum based drilling fluid.** Reed, M.G. (to Chevron Research Co.). US Patent 4,045,357. 30 Aug 1977. Filed date 23 Sep 1976. 8p.

The disclosure provides an aqueous hydroxy-aluminum drilling fluid having a ratio of hydroxy groups to aluminum atoms in the range of from 1.0 to 2.7 and a concentration of at least 0.5 molar and including an effective amount of a polymer selected from the group consisting of polyvinylpyrrolidone and polyvinyl alcohol and a corrosion inhibitor.

10782 **Subsurface well apparatus having improved operator means and method for using same.** Mott, J.D. (to Hydril Co.). US Patent 4,044,835. 30 Aug 1977. Filed date 23 Jun 1976. 22p.

The invention relates to a surface-controlled wire-line retrieval subsurface safety valve apparatus and method of utilizing the safety valve having a rotatable ball closure element and a movable operator mechanism that controls the operating stroke when the valve is operably installed as well as moving the ball and seat into sealing engagement.

10783 **Well drilling apparatus and method.** Alvis, R.L.; Newsom, M.M. (to Energy Research and Development Administration). US Patent 4,030,557. 21 Jun 1977. Filed date 3 May 1976. 8p.

PAT-APPL-682,806.

Well drilling rates may be increased by impelling projectiles to fracture rock formations and drilling with rock drill bits through the projectile fractured rock.

LASERS

REFER ALSO TO CITATION(S) 10295, 11217, 11350, 11351

10784 (CONF-760646—, pp 24-31) **Scaling law for energy transfer by inelastic electron—molecule collisions in mixtures.** Bienkowski, G.K. Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

The equation governing the electron energy distribution in the presence of a spatially uniform electric field in a weakly ionized gas has been reformulated into an integral equation for the logarithmic slope of the distribution function. For gas mixtures in which the dominant electron energy-loss mechanism is by vibrational excitation of the molecules, this equation is suitable for approximate analysis and exact numerical solution by iteration. Super-elastic collisions are easily included in this formulation, and do not seriously effect the convergence of the numerical scheme. The approximate analytical results are only qualitatively correct, but suggest appropriate parameters which correlate the exact numerical results very well. The distribution function as well as certain gross properties such as net energy transfer into vibration, mean energy, and drift velocity depend primarily on a single non-dimensional parameter involving only E/N and the cross sections. This parameter can be physically interpreted as the energy gained from the field between successive inelastic collisions divided by the typical inelastic energy loss per collision. Results for mixtures of CO, He, and N_2 are presented and shown to correlate most of the properties.

10785 (CONF-760646—, pp 32-36) **Pulser-sustainer glow discharge operation in static carbon monoxide laser mixtures.** Monson, D.J.; Lee, C.M. (National Aeronautics and Space Administration, Moffett Field, CA). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

Theoretical studies show that efficient operation of CO electric-discharge supersonic lasers requires discharge methods that allow separate control of electron density, n/sub e/, and reduced electric field, E/N (or electron energy). To date, external ionization by an electron beam has been successfully demonstrated in these lasers. Other promising (but unproven) possibilities include ultraviolet photoionization, ionization by nuclear reaction products, and a high repetition rate series of controlled avalanche ionization pulses (i.e., pulser-sustainer). Successful operation of the pulser-sustainer concept in large-volume static room temperature CO laser mixes is reported. (The concept has previously been demonstrated in small-volume static CO_2 laser mixes.) High voltage pulses and ultraviolet sparks at 33 kHz combined with a separate low voltage sustainer electric field produce spatially uniform plasmas in a 3.0 liter volume. Completely independent control of n/sub e/ and E/N is demonstrated. The tests are preliminary to testing of the concept in supersonic flow. Results include for several pure gases and mixtures the following measurements: cathode-fall voltage; self-sustaining E/N; recombination rate coefficient; average plasma n/sub e/; average discharge input power; and the maximum discharge energy loading without arcing. Modifications being made to the system to allow higher pressures and energy loadings without arcing, and to allow operation in supersonic flow are discussed.

10786 (CONF-760646—, pp 52-63) **Analysis of nuclear induced plasmas.** Deese, J.E.; Hassan, H.A. (North Carolina State Univ., Raleigh). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

A kinetic model is developed for a plasma generated by fission fragments and the results are employed to study He plasma generated in a tube coated with fissionable material. Because both the heavy particles and electrons play important roles in creating the plasma, their effects are considered simultaneously. The calculations are carried out for a range of neutron fluxes and pressures. In general, the predictions of the theory are in good agreement with available intensity measurements. Moreover, the theory predicts the experimentally measured inversions. However, the calculated gain coefficients are such that lasing is not expected to take place in a helium plasma generated by fission fragments.

10787 (CONF-760646—, pp 80-90) **Measurement techniques for analysis of fission fragment excited gases.** Schneider, R.T.; Carroll, E.E.; Davis, J.F.; Davie, R.N.; Maguire, T.C.; Shipman, R.G. (Univ. of Florida, Gainesville). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

In pursuit of nuclear pumped lasers, experimental efforts have been directed towards the measurement of population inversions in gases and determination of the fission fragment interaction processes involved. Spectroscopic analysis of fission fragment excited He, Ar, Xe, N_2, Ne, Ar-N_2, and Ne-N_2 have been conducted. Boltzmann plot analysis of He, Ar, and Xe have indicated a nonequilibrium, recombining plasma, and population inversions have been found in these gases. The observed radiating species in helium have been adequately described in a simple kinetic model. A more extensive model for argon, nitrogen and Ar-N_2 mixtures was developed which adequately describes the energy flow in the system and compares favorably with experimental measurements. The kinetic processes involved in these systems are discussed. These models have indicated a need for

the measurement of the kinetic processes in fission fragment excited gases. A ^{252}Cf source was used with a photon counting system to measure the life-times and collisional rate coefficients for gases excited by fission fragments. Experimental measurements of the energy deposition properties of fission fragments emanating from uranium oxide coatings were also performed. To develop efficient nuclear pumped lasers, the energy density requirements are high. These problems are discussed and a fissioning uranium plasma energy source is indicated. Spectral emission from Ar-N_2-UF_6 mixtures have shown that the addition of UF_6 has adverse effects on the emitting species. Further research is clearly indicated to understand the properties of fission fragment excited UF_6 and other gases which are necessary for the development of high-powered, efficient, nuclear pumped laser systems.

10788 (CONF-760646—, pp 96-101) **Direct nuclear pumped lasers using the volumetric ^3He reaction.** De Young, R.J. (Vanderbilt Univ., Nashville); Jalufka, N.W.; Hohl, F.; Williams, M.D. Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

Lasers pumped by energetic charged particles created directly by nuclear reactions have come into existence through the use of either boron-10 or uranium-235 coatings. A new class of nuclear-pumped lasers using the ^3He reaction has been developed at the Langley Research Center. Since helium is a major constituent of many gas lasers of interest, it is convenient to replace the usual ^4He with the ^3He isotope. In a thermal neutron flux, the $^3He(n,p)^3H$ reaction deposits energy nearly uniformly throughout the laser volume. The charged particles created (proton of 0.57 MeV and ^3H of 0.19 MeV) ionize and excite the gas media. By this method direct nuclear pumping of a ^3He—Ar (10 percent Ar) laser has been achieved. Results of reactor experiments are presented which show the scaling of laser output at 1.79μ (Ar I) with neutron flux and total ^3He—Ar pressure. Other laser systems presently under study at the Langley Research Center include the ^3He—Ne—O_2 (8446 A OI) system. Spectra of nuclear pumped ^3He—Ne—O_2 taken at the Aberdeen Army Pulse Radiation Facility will be presented. The above systems are considered to be "proof of principle" systems and future more practical nuclear-pumped lasers, using excimer species, are discussed.

10789 (CONF-760646—, pp 102-108) **Recent nuclear pumped laser results.** Miley, G.H.; Wells, W.E.; Akerman, M.A.; Anderson, J.H. (Univ. of Illinois, Urbana). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

Recent direct nuclear pumped laser research at the University of Illinois has concentrated on experiments with three gas mixtures (Ne—N_2, He—Ne—O_2, and He—Hg). One mixture has been made to lase and gain has been achieved with the other two. All three of these mixtures are discussed with particular attention paid to He—Hg. Of interest for DNP work is the 6150-A ion transition in Hg^+. The upper state of this transition is formed directly by charge transfer and by Penning ionization.

10790 (CONF-760646—, pp 109-114) **Nuclear fission fragment excitation of electronic transition laser media.** Lorents, D.C.; McCusker, M.V.; Rhodes, C.K. (Stanford Research Inst., Menlo Park, CA). Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

The properties of high energy electronic transition lasers excited by fission fragments are expanded. Specific characteristics of the media including density, excitation rates, wavelength, kinetics, fissile material, scale size, and medium uniformity are assessed. The use of epithermal neutrons, homogeneously mixed fissile material, and special high cross section nuclear isotopes to optimize coupling of the energy to the medium are shown to be important considerations maximizing the scale size, energy deposition, and medium uniformity. A performance limit point of approximately 1000 J/l in approximately 100 μs pulses is established for a large class of systems operating in the near ultraviolet and visible spectral regions. It is demonstrated that e-beam excitation can be used to simulate nuclear pumping conditions to facilitate the search for candidate media. Experimental data for the kinetics of a XeF^* laser operating in Ar/Xe/F_2/UF_6 mixtures are given. These reactor-pumped systems are suitable for scaling to volumes on the order of (meters)^3.

10791 (CONF-760646—, pp 239-243) **Broadband photoexcitation of lasers.** Hess, R.V. (National Aeronautics and Space Administration, Hampton, VA); Javan, A.; Brockman, P. Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

The purpose of this study is to review existing techniques and to discuss novel approaches for broadband photoexcitation of lasers. This subject is of interest because of the emergence of future intense near-equilibrium and blackbody sources, such as the gas-core reactor, and electric discharge plasma devices, which are the key to the development of intense broadband radiation sources. The possible use of radiation from solar concentrators in space also fits into this general area. The varied uses of photoexcitation of lasers are discussed ranging over direct optical pumping, photodissociation, and photopreionization. In addition, the new use of lasers for broadband photoexcitation of new laser transitions and chemical reactions is shown. This is accomplished through multiline operation of high-pressure tunable lasers which can use the broadband radiation for multiphoton excitation.

10792 (CONF-760646—, pp 275-279) **Considerations to achieve directionality for gamma ray lasers.** Jha, S. (Univ. of Cincinnati); Blue, J. Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

The study concerns a method of alignment of nuclei for a gamma ray laser and a means of achieving preferential emission of radiation along the crystal axis. These considerations are important because it probably is not possible to achieve reflection of gamma radiation in order to have photons make multiple passes through an active region. Atomic alignment has been achieved by materials researchers who have made composite structures composed of needle-like single crystals all with the same orientation and all pointing in the same direction contained in a matrix of cobalt or nickel. The proposed method of preferential emission of radiation along the aligned needles is to have a symmetric field gradient at the nucleus and a sequence of excited levels of spin and parity 2^+ and 0^+. The proposed scheme will reduce the density of excited states required for lasing and reduce the linewidth due to inhomogenous broadening. Mossbauer absorption experiments intended to test these ideas are outlined.

10793 (SAND—77-1283c) **E-beams for laser excitation.** Ramirez, J.J.; Prestwich, K.R.; Clark, R.S.; Buttram, M.T. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 12p. (CONF-771035—2). Dep. NTIS, PC A02/MF A01.

From 2. international topical conference; Ithaca, New York, USA (3 Oct 1977).

The operating characteristics of a 1 MV, 200 kA, 20 ns radial electron beam diode are presented together with beam transport and deposition measurements in various gases. Initial results on the emission characteristics and stability of 1 to A/cm^2, 1 μsec diodes are described.

10794 (UCRL—13765) **Development of copper halide laser system. Final report, May 6, 1976—January 17, 1977.** Weaver, L.A.; Feldman, D.W.; Pack, J.L.; Liu, C.S. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Research and Development Center). 31 Jan 1977. Contract W-7405-ENG-48. 62p. Dep. NTIS, PC A04/MF A01.

The results of experiments on copper halide laser developments are described. Several discharge-heated CuBr lasers with average output power between 2.0 and 6.5 W have been demonstrated at approximately 16 kHz. A 2 W CuBr laser has been operated for over 100 h without either tube or pulser failure. It is believed that the operating lifetime of this sealed-off, isothermal laser system is the longest reported to date for any copper laser. The design concepts and fabrication technologies of quartz copper halide laser tubes and high prf, high power pulsers were proven to be practical and successful. Scaling the average power of copper halide laser systems from the present few watts to several tens of watts in the future is realistic and attainable. System analysis of a life test setup indicates that the existing CuBr laser system should be able to operate beyond 500 hours without failure. Lifetimes extending beyond several thousand hours can be achieved with further engineering development.

10795 (Y/DA—7477) **Materials for high-temperature hydrogen—fluorine environments.** Holcombe, C.E.; Kovach, L.; Weber, G.W. (Oak Ridge Y-12 Plant, Tenn. (USA)). 3 Oct 1977. Contract W-7405-ENG-26. 93p. Dep. NTIS, PC A05/MF A01.

The design, construction, and operation of a facility for the testing of materials under a hydrogen-fluorine torch are discussed. Tested materials are candidates for use as uncooled nozzles for a hydrogen-fluorine laser system currently being developed by the Air Force Weapons Laboratory. The behavior of 40 different compounds, solid solutions, and elements has been evaluated in the HF materials test facility including nine varieties of carbon. Data from 106 runs on these materials are reported. Observations, measurements, and test conditions are summarized.

10796 Generation of single ultrashort CO_2 laser pulses in a Fabry—Perot interferometer. Fisher, R.A.; Feldman, B.J. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Opt. Lett.;* 1: No. 5, 161-163(Nov 1977).

In a manner analogous to optical free-induction decay, we have generated ultrashort (<100 psec) intense infrared optical pulses by reflecting an abruptly terminated CO_2 laser pulse from an appropriately adjusted Fabry—Perot interferometer. Because a suitable resonantly absorbing material is not required, the scheme is applicable to any intense narrow-band laser system.

10797 Repetitively pulsable traveling wave laser. Collins, C.B. Jr. US Patent 4,053,853. 11 Oct 1977. Filed date 18 Aug 1975. 8p.

A system for producing repetitive stimulated emission pulses of coherent electromagnetic radiation which operates in a traveling wave mode is disclosed. Each pulse of coherent electromagnetic energy is produced by applying a single high voltage pulse to a plurality of pulse transmission lines of progressively greater electrical lengths which are connected at spaced points to electrodes extending parallel to and disposed on opposite sides of a discharge channel which contains a laser type medium. As a result, the pulse is applied to successive points along the discharge channel as the stimulated radiation wave front approaches the respective points, providing optimum efficiency. A number of such systems can be cascaded to produce theoretically unlimited power. In the preferred embodiment, the transmission lines are strip transmission lines formed by printed circuit techniques and include impedance matching connections at the electrodes to provide enhanced efficiency. The rapid rise pulse is applied to the transmission lines by a thyratron or other switching device.

10798 Chambered mirror construction for lasers. Simmons, G.P.; Brubaker, H.A.; Streight, W.E. (to Caterpillar Tractor Co.). US Patent 4,053,241. 11 Oct 1977. Filed date 24 May 1976. 4p.

A system for cooling a mirror such as a laser mirror is provided. The system includes a mirror having a reflective surface and a plurality of coolant chamber cavities arranged in serial order from an inlet to an outlet. Restrictive flow passages formed within walls between the cavities control coolant flow and produce desired turbulence within the cavities for enhanced heat transfer from the mirror to the coolant.

10799 X-ray laser utilizing gas jet. Scully, M.O. (to University Patents, Inc.). US Patent 4,053,783. 11 Oct 1977. Filed date 29 Oct 1974. 4p.

In accordance with the invention there is provided a means for producing a gas jet target capable of population inversion. Also provided is a means for generating an ion beam and a means for scanning the ion beam longitudinally along the gas jet so as to cause emission therefrom. The scanning speed is established as being substantially equal to the wavefront velocity of the emission; i.e., the speed of light. A hydrogen gas jet overcomes problems encountered using a thin hydrogen-rich foil. The hydrogen jet is not destroyed by the ion beam and the problem of making a suitable thin foil is eliminated. Also, by employing an appropriate beam density, the Doppler width is reduced as compared to the foil so that gain improvement can be achieved.

10800 Gas-discharge laser. Bulthuis, K.; Derksema, B.J.; Dijkstra, H.T.; van de Wal, J. (to U.S. Philips Corp.). US Patent 4,052,681. 4 Oct 1977. Priority date 13 Mar 1975, Netherlands. 4p.

A gas-discharge laser having a Brewster window near at least one of the reflectors which is secured directly to the laser tube is described. The Brewster window is secured to a surface of the laser tube and a normal to the window makes an angle equal to the Brewster angle with the axis of the laser tube. The surface may be a slot in the laser tube or a recessed end face of the laser tube near a reflector. An advantage is that the Brewster window may have any convenient diameter and that the laser tube need not be drilled to form a cavity.

10801 Metal vapor laser having cataphoresis means. Wang, S.C.; Hamerdinger, R.W.; Hug, W.F. (to Xerox Corp.). US Patent 4,052,680. 4 Oct 1977. Filed date 1 Jul 1976. 6p.

A radiation emission device characterized by a cylindrical cathode enclosed by an elongated envelope having a body section and two end sections is disclosed. The device includes an anode terminal, coupled to the body section, which serves to provide electrical energy to excite metallic material inside the envelope. The device further includes a pair of cataphoresis terminals located along each end section to prevent the excited metallic material from drifting into contact with radiation transmission windows located at the terminus of each end section.

10802 In cavity pumping for infrared laser. Barry, J.D.; Brandelik, J.E. (to Secretary of the Air Force). US Patent 4,050,034. 20 Sep 1977. Filed date 30 Apr 1975. 4p.

A far infrared laser having a CO_2 laser gas cell located in the same optical cavity as the far infrared cell is described. The CO_2 gas is made to flow through the CO_2 cell within the laser cavity and the far infrared gas is made to flow in the far infrared cell within the laser cavity. The current is supplied between a pair of electrodes in the CO_2 cell to excite the CO_2 gas. The far infrared molecules are pumped by optical energy transfer from the CO_2 laser radiation. The infrared radiation is removed by an aperture in one of the mirrors and a far infrared transparent window.

10803 Submillimeter wave and far infrared molecular lasers and polyatomic buffer gases therefor. Chang, T.Y.; Lin, C. (to Bell Telephone Labs., Inc.). US Patent 4,050,033. 20 Sep 1977. Filed date 12 Nov 1975. 10p.

The optically pumped submillimeter wave lasers employing molecular gases having dipole moments are improved by employing as a polyatomic buffer gas a molecular gas or vapor of a hydrocarbon having a significantly large vibrational heat capacity in relation to its molecular weight. An example is C_6H_{14} added to such lasers as the methyl fluoride laser at 496 micrometers. Other examples of saturated hydrocarbon buffers are also given; and in each case the vapor molecule is complex enough to absorb many vibrational quanta from the active molecules, yet is small enough to move rapidly to the tube walls.

10804 Laser beam alignment. Knowles, C.H.; Meckely, J.R.; Naylor, C.A. (to Metrologic Instruments, Inc.). US Patent 4,050,037. 20 Sep 1977. Filed date 10 Jun 1976. 4p.

A laser tube is rigidly mounted within a cylindrical metallic housing, and end rings are attached thereto. Each end ring has an opening for passage of the beam, and a plurality of radially disposed openings. Inside the housing, a smaller adjustment ring is provided, and outside the end rings are reference rings adapted to receive lenses, filters, or the like. Screws engage and penetrate the outer ring, pass freely through the end ring, and engage the inner ring. The outer and inner rings are movably adjustable relative to the housing axis and the laser beam, whereby optical apparatus attached to the outer ring may be positioned precisely relative to the laser beam.

10805 Optical system for lasers. Chambers, W.A.; Bossler, F.B.; Brandkamp, W.F. (to Textron Inc.). US Patent 4,050,036. 20 Sep 1977. Filed date 25 Feb 1976. 6p.

A laser configuration is disclosed wherein the active region is of annular cylindrical form. Zero mode azimuth coupling which produces an output beam of low obscuration ratio in the near field, thereby providing a single lobe in the far field, is achieved by the use of an unstable optical resonator characterized by an annular mirror defining one end of the resonator and a two stage axiconic reflector disposed optically between the opposite ends of the resonator.

10806 Self-aligned polarized laser. Wuerker, R.F.; Heflinger, L.O. (to TRW Inc.). US Patent 4,050,035. 20 Sep 1977. Filed date 13 Feb 1976. 8p.

A laser of the type which generates linearly polarized light and including optical means for self-alignment is presented. Among such polarized lasers are, for example, solid state lasers and particularly ruby lasers, as well as various gas lasers employing Brewster windows. The problem is solved by utilizing a corner reflector in the laser cavity which generates two parallel laser beams. In order to achieve effective laser operation the polarization determining aspect of the laser, that is the crystal axis or Brewster windows, must be so oriented with respect to the corner reflector that the laser beam in passing through the laser is so reflected by the corner reflector that the light will return through the laserable material with the same direction of polarization as that of the original laser beam generated by the laser.

10807 Bismuth halide vapor laser. Liu, C.; Weaver, L.A.C. (to Westinghouse Electric Corp.). US Patent 4,048,587. 13 Sep 1977. Filed date 9 Jul 1976. 4p.

The low temperature operation, i.e., between 300 and 500°C, of a bismuth halide vapor laser avoids the formation of the metal dimer Bi_2, the occurrence of which in the operation of a pure bismuth laser significantly reduces the gain and stimulated output due to absorption of the laser energy. The successful operation of a bismuth halide laser provides the basis for developing a laser operating in the underwater transmission band of between 4,700 and 4,800 A which lies near the minimum of the sea water absorption scattering curve thus rendering it a prime candidate for underwater applications.

10808 Chemical laser with mixing enhancement device for power improvement. Witte, A.B.; Broadwell, J.E.; Hook, D.L. (to TRW Inc.). US Patent 4,048,586. 13 Sep 1977. Filed date 12 Jan 1976. 6p.

An inert diluent such as N_2, He, Ar, etc., is injected into the reactant streams emerging from the cavity nozzle of a cw, supersonic, laser to increase the cavity power and lower the cavity temperature by enhancing mixing of the reactant stream while maintaining high pressure recovery.

10809 Broadband laser with intracavity crystal for generating second harmonic radiation. Liu, Y.S. (to General Electric Co.). US Patent 4,048,515. 13 Sep 1977. Filed date 14 Jun 1976. 6p.

High power, high efficiency second harmonic generation is obtained by employing a nonlinear optical crystal inside the cavity of a broadband laser. The birefringent property of the crystal and the nonlinear parametric interaction produce frequency doubling and line-narrowing simultaneously, facilitating high efficiency operation.

10810 Electron beam pumped gas laser. Dreyfus, R.W. (to International Business Machines Corp.). US Patent 4,047,125. 6 Sep 1977. Filed date 3 May 1976. 8p.

An electron beam pumped gas laser is described that includes an evacuated cavity adapted to house a lasing gas and an electron beam launching means (such as a field emission diode). Means are provided to insert a lasing gas into the cavity so as to produce a traveling density discontinuity. The diode is energized prior to the time the traveling density discontinuity reaches it so as to launch an electron beam under substantially evacuated conditions. The principles of the invention can also be applied to gaseous electron beam transport.

10811 Planar solid state laser array. Comerford, L.D.; Zory, P.S. Jr. (to International Business Machines Corp.). US Patent 4,047,124. 6 Sep 1977. Filed date 31 Dec 1975. 4p.

An array of collimated wise aperture electrically pumped leaky corrugated AlGaAs optical waveguide lasers is formed on a single chip by etching a series of grooves oriented with respect to the crystallographic planes to isolate discrete lasers in the array and provide the requisite orientation of the internal reflecting surfaces to support the lasing action. The corrugation period is chosen such that the laser radiation exits from the array in a direction normal to the plane of waveguide.

10812 Corrugation coupled twin guide laser. Burnham, R.D.; Scifres, D.R.; Streifer, W. (to Xerox Corp.). US Patent 4,045,749. 30 Aug 1977. Filed date 24 Nov 1975. 8p.

An electrically pumped distributed feedback grating coupled diode laser is described that has an optical cavity containing two closely spaced layers; a first of the layers is electrically pumped and the second of the layers is corrugated. Optical wavelength radiation and amplification of said radiation is generated in the first layer by carrier recombination with the radiation spreading to the second layer for coherent reflection by the corrugation and for low loss transmission. Carrier confinement in the first layer and optical confinement in the optical cavity are achieved by surrounding each of these layers by materials having a higher bandgap and lower index of refraction than the materials of the first and the second layers. The corrugation of the second layer can extend over only a portion of the length of the second layer such that the uncorrugated potion of the second layer provides a low loss waveguide.

10813 Means for producing and amplifying optical energy. Snitzer, E. (to American Optical Corp.). US Patent 4,044,315. 23 Aug 1977. Filed date 16 Jan 1962. 22p.

The laser consists of a solid luminescent sensitive element of Fabry-Perot optical regenerative configuration and is essentially a clear glass activated with trivalent ytterbium ions. 42 claims, 13 figures.

10814 Stabilized cavity-dumped ND:YAG laser. Kennedy, C.J. (to Secretary of the Air Force). US Patent 4,044,316. 23 Aug 1977. Filed date 19 Apr 1976. 4p.

In cavity dumped state lasers, the relaxation oscillations caused by cavity dumping are stabilized and damped out by placing a non-linear second-harmonic generation crystal inside the optical cavity of the laser and phase-matching it to produce a doubled frequency component of approximately 0.1 percent that of the circulating power. The degree of damping depends on the conversion percentage, which may be varied by temperature controlling the frequency doubling crystal. A conventional antireflection coating is placed on the crystal to minimize losses.

10815 Hypersonic gas laser. Fenneman, D.B. (to Secretary of the Navy). US Patent 4,042,892. 16 Aug 1977. Filed date 22 Jul 1976. 4p.

A hypersonic gas laser to produce coherent infrared electromagnetic radiation for use in communication, illumination, energy transmission or weather control is described. The lasing device uses an interaction area consisting of a grid of fine wires or the like to convert the kinetic energy of hypersonic velocity gases to vibrationally excited nitrogen from which the laser energy is extracted.

10816 Coaxial electron beam pumped laser. Ault, E.R.; Stevens, P.C.; Sipman, R.H.; Bradford, R.S. Jr. (to Northrop Corp.). US Patent 4,041,415. 9 Aug 1977. Filed date 7 May 1976. 4p.

An e-beam pumped laser is described that employs a hollow cylindrical anode and cathode structure, the cathode being externally concentric with the anode. The lasing gas is contained within a chamber formed by the anode, an optical oscillator cavity being formed between mirrors placed at opposite ends of the anode chamber. The laser gas is excited by means of an e-beam directed radially inwardly from the cathode through the walls of the anode, which are formed of a thin foil, into the laser gas cavity.

10817 Multiple arc radiation preionizer for gas lasers. Richardson, M.C.; Leopold, K. (to Canadian Patents and Development Ltd.). US Patent 4,041,414. 9 Aug 1977. Priority date 30 May 1973, Canada. 4p.

A multiple arc radiation preionizer for gas lasers is described that is formed of a metal electrical conductor with the conductor having formed over a portion of its length, a series of gaps to form a series of intervening discharge electrodes such that on energization of the conductor, a multiplicity of arc discharges is obtained. In a first embodiment the conductor is formed or positioned over the surface of a dielectric sheet such that arcs formed between electrodes are conducted over the surface of the sheet. The discharge electrodes are capacitively connected to ground or the low voltage side of the input via individual low-valued capacitors or by means of a conductor positioned in spaced relation to said electrodes. In the preferred embodiment, the preionizer is formed of a multiplicity of parallel conductors mounted on a dielectric sheet with the conductors each having a multiplicity of gaps therein forming a series of discharge electrodes each of which is connected through a capacitance to ground or a common voltage level such that on energization of the conductors from a high voltage pulse source, a two-dimensional array of a large number of arc discharges is obtained.

10818 Laser unit with a laser beam automatically aligned to the vertical direction. Tagnon, L.A. (to Essilor International (Compagnie Generale d'Optique)). US Patent 4,040,752. 9 Aug 1977. Priority date 24 Apr 1974, France. 8p.

Laser unit is described for directing a laser beam in a strictly vertical direction, comprising a laser proper having a substantially vertical axis, an afocal system, an optical device for automatically correcting the verticality of the laser beam, and a base structure provided with means for supporting the assembly of said laser, afocal system and optical device in such position that the laser axis be substantially vertical. The invention is applicable to all fields and techniques in which it is desired to determine with the maximum precision the vertical at a given locus where the laser is installed.

10819 Investigation of a copper vapor pulsed laser at elevated powers. Isaev, A.A.; Lemmerman, G.Y. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 7, 799-801(Jul 1977).

Pulsed stimulated emission from a copper vapor laser was studied at supply powers of up to 5 kW in two discharge tubes with internal diameters of 20 and 30 mm and active lengths of 700 and 800 mm, respectively. Three TGI1-1000/25 thyratrons connected in parallel were used to increase the supply power. A maximum average stimulated emission power of 43.5 W was obtained with a practical efficiency of 1%. A peak output power of 200 kW was achieved.

10820 Investigation of the output characteristic of a rotating ring gas laser. Privalov, V.E.; Filatov, Y.V. (D. I. Mendeleev All-Union Scientific-Research Institute of Metrology, Leningrad). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 7, 802-806(Jul 1977).

An analysis is made of a general expression for the output characteristic of a rotating ring gas laser. The results are given of an experimental investigation of the splitting of the normal frequencies of a rotating ring resonator containing a homogeneous dielectric medium. It is shown that the splitting is inversely proportional to the refractive index of the medium in the resonator. Methods for reducing the backscattering coupling between the opposite waves are considered. It is shown experimentally that a compensation method involving the use of return mirrors can reduce drastically the coupling between the opposite waves.

10821 High-contrast power resonances in an He—Ne/$^{127}I_2$ laser with a large effective absorption length. Mogil'nitskii, B.S.; Kolomnikov, Y.D. (Siberian State Scientific-Research Institute of Metrology, Novosibirsk). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 7, 810-813(Jul 1977).

An analysis is made of the conditions for obtaining high-contrast resonances in a weakly saturable absorber. A description is given of an experiment in which high-contrast power resonances were established in an He—Ne/$^{127}I_2$ laser. An optical delay line is used as an internal absorption cell for the purpose of increasing the effective absorption length. An analysis is made of the spectrum of the hyperfine structure of the absorption in iodine in this laser. The stability of the laser when locked to one of these resonances is determined.

10822 Investigation of the properties of an unstable resonator using a dihedral corner reflector in a continuous-flow cw CO_2 laser. Anan'ev, Y.A.; Kuprenyuk, V.I.; Sergeev, V.V.; Sherstobitov, V.E. *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 7, 822-824(Jul 1977).

An analysis is made of the possibility of using a dihedral corner reflector in unstable resonators of continuous-flow gas lasers. It is shown that the use of this type of reflector enables a sharp increase to be obtained in the uniformity of distribution of the radiation over the cross section of the resonator.

10823 Model of a medium for design of resonators of gasdynamic CO_2 lasers. Aleksandrov, B.S.; Anan'ev, Y.A.; Lavrov, A.V.; Trusov, V.P. *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 7, 825-828(Jul 1977).

An analysis is made of the possibility of applying a mathematical model of a medium with just two equations in the design of gasdynamic laser resonators. It is shown that this model ensures a satisfactory precision of the calculations in a certain range of parameters of the active medium.

10824 Frequency conversion of cw chemical HF laser radiation in nonlinear crystals. Klement'ev, V.M.; Kolpakov, Y.G.; Pecherskii, Y.Y. (Institute of Semiconductor Physics, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 7, 828-831(Jul 1977).

A description is given of a cw chemical HF laser and its characteristics. The results are reported of investigations of the efficiency of conversion of the HF laser radiation into second harmonics and combination frequencies in $LiNbO_3$, $LiIO_3$, and Ag_3AsS_3 crystals. The most efficient conversion was achieved in proustite (Ag_3AsS_3) when the second-harmonic power was $\sim 3\mu W$ and the fundamental-frequency power was ~ 100 mW. Twenty-one emission lines were obtained in the 1.39—1.49 μ range. The HF laser radiation was converted to the visible range (0.522—0.516 μ).

10825 Gain of a CO_2 waveguide laser. Grigor'yants, V.V.; Kuzyakov, B.A.; Sinitsyn, A.M. (Institute of Radioelectronics, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 7, 836-840(Jul 1977).

An analytic expression is obtained for the unsaturated gain of the active medium in a CO_2 waveguide laser. A calculation is reported of the gain in a CO_2:N_2:He=1:1:8 mixture. The dependence of the gain on the pressure in the active medium and on the laser tube diameter is obtained for different pump currents. The role of various mechanisms of the relaxation of excited molecules in the plasma of a CO_2 waveguide laser is considered.

10826 Investigation of submillimeter-wave amplification in optically pumped molecular gases. Dyubko, S.F.; Fesenko, L.D.; Baskakov, O.I. (A. M. Gorki State University, Kharkov). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 7, 859-862(Jul 1977).

The results are presented of measurements of the gain for certain emission lines of cw optically pumped submillimeter lasers utilizing HCOOH, CH_3OH, $C_2H_2F_2$, CH_3I, and CD_3I molecules. The gain was measured as a function of the intensity of the pump radiation, gas pressure, and polarization of the input signal. The degree of polarization anisotropy of the excited medium depended on the type of pumping transition. The largest gain, 3.15 dB/m, was obtained for the $\lambda=432.6\mu$ transition in the HCOOH molecule.

10827 Continuous dynamic frequency tuning of pulse laser radiation. Makogon, M.M.; Serdyukov, V.I.; Solodov, A.M. (Institute of Atmospheric Optics, Siberian Division, Academy of Sciences of the USSR, Tomsk). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 7, 875-876(Jul 1977).

It is demonstrated for the first time that stimulated emission tuned continuously over a wide range can be obtained from pulse lasers with wide gain profiles (including solid-state lasers). The tuning range is at least two orders of magnitude greater than the intermode spacing and this is achieved by varying the length of a resonator emitting quasicontinuously by 100 or more wavelengths during stimulated emission. A report is given of experimental attainment of continuous tuning of single-mode neodymium laser radiation in a range of 0.5 cm^{-1}. Estimates obtained indicate that under certain conditions it is possible to achieve continuous tuning of ruby laser radiation in the range 1—2 cm^{-1}, of neodymium glass laser radiation in the range 5—8 cm^{-1}, and of dye laser radiation in a range up to 100 cm^{-1}.

10828 Theoretical investigation of the possibility of generation of short high-power pulses in an electron-beam-controlled CO laser. Dolinina, V.I.; Suchkov, A.F.; Urin, B.M. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 7, 890-891(Jul 1977).

A theoretical analysis is made of the possibility of the generation of short high-power pulses in an electron-beam-controlled CO laser both under Q-switching and free-oscillation conditions. Calculations indicate that, in principle, ~ 20 nsec pulses can be generated with an efficiency of $\sim 10\%$.

10829 Time dependence of the electron density in a copper vapor laser. Batenin, V.M.; Burmakin, V.A.; Vokhmin, P.A.; Evtyunin, A.I.; Klimovskii, I.I.; Lesnoi, M.A.; Selezneva, L.A. (Institute of High Temperatures, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 7, 891-893(Jul 1977).

The time dependence of the electron density was determined for a copper vapor laser emitting pulses at a frequency of 7.2 kHz. The value of the density n/sub e/ during a current pulse was calculated from the measured resistance of the discharge gap. Between the current pulses, the density was measured with a laser interferometer. A comparison was made of the ionization frequency of an Ne—Cu mixture with the ionization frequency of pure neon.

10830 Relaxation processes in the discharge used in a copper halide laser. Oleinik, Y.M.; Rogozhin, A.V. *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 7, 893-895(Jul 1977).

A spectrographic investigation was made of the radiation emitted from pulse discharges in mixtures of CuBr and CuI with Ne and He. The dependence of the relative intensity of the molecular spectrum on the discharge conditions and the time characteristics of the deexcitation of the resonance and laser lines of Cu I were determined. Prolonged afterglow due to the $3d^{10}nx—3d^{10}4p^2P^o$/sub 3/2,1/2/ and $3d^{10}nx—4s^2\ ^2D$/sub 3/2,5/2/ in Cu I was observed. The possibility that the discharge contraction was due to an increase in the importance of the dissociative recombination processes was considered. It was concluded that cooling of electrons played an important role in the deactivation of the metastable states of Cu I.

10831 Amplitude- and phase-frequency characteristics of a YAG:Nd^{3+} laser with intracavity second harmonic generation. Dmitriev, V.G.; Novokreshchenov, V.K. *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 7, 899-901(Jul 1977).

An analysis is made of the amplitude and phase of small fluctuations of the fundamental-frequency and second-harmonic power experienced by a YAG:Nd^{3+} laser in the case of small fluctuations of the losses and nonlinear coupling coefficient. It is shown that the amplitude- and phase-frequency characteristics of this laser are basically different from those observed in the absence of second harmonic generation.

10832 Internal modulation of gas laser radiation by acoustic surface waves. Belova, G.N. (Acoustics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 7, 906-908(Jul 1977).

A method for internal modulation of gas lasers by acoustic surface waves is analyzed theoretically. It is shown that excitation of a traveling amplitude-modulated surface wave in one of the resonator mirrors may, under certain conditions, modulate the laser radiation at the frequency of modulation of the acoustic wave amplitude. The modulation of the laser radiation is due to the periodic variation of the losses in the resonator. The depth of the power modulation depends on the amplitude, frequency, and depth of modulation of the acoustic wave. Experiments are reported in which He—Ne laser radiation ($\lambda=0.63\ \mu$) was modulated between 100 Hz and 10 kHz by exciting a traveling amplitude-modulated acoustic surface wave of 10 MHz frequency in a resonator mirror. The relationships describing the modulation process were in good agreement with the theory.

10833 High-pressure ultraviolet-emitting KrF laser. Basov, N.G.; Brunin, A.N.; Danilychev, V.A.; Degtyarev, A.G.; Dolgikh, V.A.; Kerimov, O.M. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 7, 908-910(Jul 1977).

Electron-beam pumping of Ar—Kr—F_2 and Ar—Kr—Nf_3 mixtures produced stimulated emission at the wavelength of 248.6 nm. An investigation was made of spectral, energy, and time characteristics of the spontaneous and stimulated radiation as a function of the composition of the mixtures at pressures of 0—10 atm. The efficiency of conversion of the electron-beam energy into the energy of spontaneous radiation at the 248.6 nm wavelength was $\sim 15\%$ for the optimal composition Ar:Kr:F_2=1000:10:1.

10834 High-power hydrogen laser emitting vacuum ultraviolet radiation at high pulse repetition frequency. Lozovskii, P.M.; Chernov, S.P.; Essel'bakh, P.B. (M. V. Lomonosov State University, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 7, 916-917(Jul 1977).

An experimental study was made of a high-power hydrogen laser emitting vacuum ultraviolet radiation at a pulse repetition frequency up to 400 Hz. The laser was characterized by high values of the average power (10 mW) and high stability (10%). A new system of combining elements of a strip line with a laser cell made it possible to eliminate completely the danger of breakdown to the connected apparatus and to the vacuum pump system; moreover, pulsed electrical strays were avoided. A study was made of the pressure dependence of the output power in the range $10^{-3}—10^{-1}$ atm, which could not be done in earlier investigations because of the electrical breakdown mentioned above. The pressure dependence of the output power was found to be nonmonotonic.

10835 Optical heterodyning of spontaneous emission of an He—Ne laser (3.39-μm wavelength). Zmievskoi, G.N.; Mazanko, I.P.;

Sviridov, E.V. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **42**: No. 6, 591-593(Jun 1977).

The spectral characteristics of spontaneous emission in a laser operating on a Ne^{20}—He^3 mixture ($\lambda = 3.39$ μm were investigated by the method of optical heterodyning. The lasers investigated operated both in the linear regime as well as in a saturation regime produced by an external monochromatic signal. It was found that under the action of an external field the shape of the $3s_2$—$3p_4$ spectral line departs from a Gaussian shape. The amplification effect of the medium on the shape of the spectrum and the intensity of the spontaneous emission line is considered.

10836 Method and apparatus for tuning high power lasers. Hutchinson, D.P.; Vandersluis, K.L. (to Energy Research and Development Administration). US Patent 4,019,157. 19 Apr 1977. Filed date 6 Apr 1976. 4p.

PAT-APPL-674,262.

High power gas lasers are described that are adapted to be tuned to a desired lasing wavelength through the use of a gas cell to lower the gain at a natural lasing wavelength and "seeding" the laser with a beam from a low power laser which is lasing at the desired wavelength. This tuning is accomplished with no loss of power and produces a pulse with an altered pulse shape. It is potentially applicable to all gas lasers.

10837 Active/passive mode-locked laser oscillator. Fountain, W.D.; Johnson, B.C. (to Energy Research and Development Administration). US Patent 4,019,156. 19 Apr 1977. Filed date 2 Dec 1975. 6p.

PAT-APPL-636,864.

A Q-switched/mode-locked Nd : YAG laser oscillator employing simultaneous active (electro-optic) and passive (saturable absorber) loss modulation within the optical cavity is described. This "dual modulation" oscillator can produce transform-limited pulses of duration ranging from about 30 psec to about 5 nsec with greatly improved stability compared to other mode-locked systems. The pulses produced by this system lack intrapulse frequency or amplitude modulation, and hence are ideally suited for amplification to high energies and for other applications where well-defined pulses are required. Also, the pulses of this system have excellent interpulse characteristics, wherein the optical noise between the individual pulses of the pulse train has a power level well below the power of the peak pulse of the train.

10838 Analytic model for the electric CO laser. Gordiets, B.F.; Mamedov, S.S. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 4, 498-502(Apr 1977).

A simplified analytic model is developed for the cw electric CO—He laser. The anharmonic Morse model is used to find an analytic expression for the vibrational distribution function in CO. Various processes are taken into account: vibrational—vibrational and vibrational—translational energy exchange, spontaneous radiative transitions, and diffusion of excited molecules to the wall. The effect of radiation reabsorption on the vibrational relaxation is also included. The most important properties governing the laser operation: the "vibrational" temperature, the gas temperature, and the gain: are calculated as functions of the discharge properties, specifically, the current density, the radius of the discharge tube, the wall temperature, the total and partial gas pressures, and the electric field. The results are compared with experiment.

10839 Co-axially pumped, narrow band, continuously tunable, high power vuv xenon laser. Bradley, D.J.; Hull, D.R.; Hutchinson, M.H.R.; McGeoch, M.W. (Imp Coll of Sci and Technol, London, Engl). *Opt. Commun.;* **14**: No. 1, 1-3(May 1975).

High efficiency spectral narrowing to 0.13 nm and frequency tuning from 169 nm to 176 nm has been produced with a new design of coaxial-pumped xenon laser employing a single intra-cavity prism. The laser peak power is 3 Mw (9mJ) and becomes 0.7 Mw (power density 10 Mw cm^{-2}) when frequency narrowed.

10840 Electronic tuning of dye lasers by an electrooptic birefringent Fabry-Perot etalon. Okada, M.; Ieiri, S. (NHK (Jpn Broadcast Corp), Tokyo). *Opt. Commun.;* **14**: No. 1, 4-7(May 1975).

An electrooptic birefringent Fabry-Perot etalon is described for a wavelength selector of dye lasers. The laser emission was electronically tuned with a linewidth of several angstroms over 135 A. This was achieved by changing the applied voltages from -1.2 to +1.2 kv to the etalon constructed from a 3.6 mm long, $LiTaO_3$ crystal.

10841 Transistor oscillator for pumping a semiconductor injector laser. Kusurgashev, S.V. *Instrum. Exp. Tech. (USSR) (Engl. Transl.);* **18**: No. 1, 190-192(Jan-Feb 1975).

A transistor pulse generator is described for pumping a semiconductor injection laser. The generator includes a step-down transformer operating at room temperature and has a resistance of 11 Ω. The generator produces pumping current pulses of rectangular shape at a repetition frequency of up to 3 kHz. The amplitude of the current pulses can be varied from 5 to 13 A, and the pulse length can be varied from 50 to 300 nsec. The rise time of the pulses is 10-20 nsec, and the fall time is 5-15 nsec.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 9560, 10328, 10346

10842 (DP—1455, pp 247-249) **Three-dimensional modeling of primitive equations by strongly implicit techniques.** Pepper, D.W. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

A numerical model was developed which solves three-dimensional, laminar flow in enclosures. The technique can be used to solve natural convection as well as recirculating flow problems. The method is based on an extension of the two-dimensional, strongly implicit procedure (SIP) previously used by Pepper and Harris. Preliminary results are in good agreement with prior experimental and theoretical results (although limited). Although the method requires a considerable amount of storage, computation times are relatively fast due to the efficient use of matrix inversions.

MATERIALS TESTING

10843 Apparatus for obtaining radiographs. Frank, L.F. (to Eastman Kodak Co.). US Patent 4,047,031. 6 Sep 1977. Filed date 22 Apr 1976. 6p.

An apparatus for making x-ray pictures by imagewise exposing a cloud chamber containing a high atomic number gas mixed with a condensate vapor is described. The gas is under sufficiently high pressure to assure substantially complete absorption of the incident x-rays. Optical means are provided so that visible x-ray tracks are viewed from a direction aligned with the tracks.

10844 Ultrasonic probe system for the bore-side inspection of tubes and welds therein. Von Cook, K.; Koerner, D.W.; Cunningham, R.A. Jr.; Murrin, H.T. Jr. (to Energy Research and Development Administration). US Patent 4,037,465. 26 Jul 1977. Filed date 19 Nov 1976. 6p.

PAT-APPL-743,371.

A probe system is provided for the bore-side inspection of tube-to-header welds and the like for small diameter tubes. The probe head of the system includes an ultrasonic transmitter-receiver transducer, a separate ultrasonic receiver, a reflector associated with the transducer to properly orient the ultrasonic signal with respect to a tube wall, a baffle to isolate the receiver from the transducer, and means for maintaining the probe head against the tube wall under investigation. Since the probe head must rotate to inspect along a helical path, special ultrasonic signal connections are employed. Through the use of the probe, flaws at either the inner or outer surfaces may be detected.

10845 Method of simulating spherical voids for use as a radiographic standard. Foster, B.E. (to Energy Research and Development Administration). US Patent 4,028,545. 7 Jun 1977. Filed date 17 Feb 1976. 2p.

PAT-APPL-658,806.

A method of simulating small spherical voids in metal is provided. The method entails drilling or etching a hemispherical depression of the desired diameter in each of two sections of metal, the sections being flat plates or different diameter cylinders. A carbon bead is placed in one of the hemispherical voids and is used as a guide to align the second hemispherical void with that in the other plate. The plates are then bonded together with epoxy, tape or similar material and the two aligned hemispheres form a sphere within the material; thus a void of a known size has been created. This type of void can be used to simulate a pore in the development of radiographic techniques of actual voids (porosity) in welds and serve as a radiographic standard.

10846 Eddy-current system for the vibration-testing of blades. Jacobs, M.E. (to Energy Research and Development Administration). US Patent 4,026,142. 31 May 1977. Filed date 10 May 1976. 8p.

PAT-APPL-685,013.

An improved system is described for the vibration-testing of cantilevered non-ferrous articles by inducing eddy currents. The principal advantage of the system is that relatively little heat is generated in the article being vibrated. Thus, a more accurate measurement of the fatigue characteristics of the article is obtained. Furthermore, the generation of relatively little heat in the blade permits tests to be conducted in low-pressure atmospheres simulating certain actual processes environments. Heat-generation in the vibrated article is minimized by utilizing eddy currents which are generat-

ed by an electromagnet whose magnetic field varies but does not change polarity. The typical winding for the electromagnet is excited with pulsating dc. That is, the winding is alternately charged by connecting it across a dc power supply and then discharged by connecting it across a circuit for receiving current generated in the winding by self-induction. Preferably, the discharge circuit is designed so that the waveform of the discharging current approximates that of the charging current.

ELECTRONIC CIRCUITS AND DEVICES

REFER ALSO TO CITATION(S) 10070, 10882, 11400

10847 (BMFT-FB-T—76-67) **Measurement of the minority carrier lifetime in silicon to determine material quality.** Bernt, H.; Schwab, G.; Eder, A.; Spoehrle, H.P. (Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Muenchen (Germany, F.R.). Inst. fuer Festkoerpertechnologie). Dec 1976. 92p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

A new method was developed to measure the minority carrier lifetime in silicon. For that purpose we investigated the frequency dependence of the photocurrent of a Schottky contact irradiated with sinemodulated light. It can be shown that in a suitable frequency range the photocurrent has a phase delay to the incident light which is proportional to the lifetime. Therefore, the results can be easily evaluated. The use of a mercury-Schottky-contact makes possible nondestructive measurements and spatial resolution (lifetime profiles).

10848 (N—77-14540) **Proceedings of conference on charge-coupled device technology and applications.** (National Aeronautics and Space Administration, Pasadena, Calif. (USA); Jet Propulsion Lab., Pasadena, Calif. (USA)). 1976. 180p. (CONF-761117—; JPL-SP—43-40). NTIS.

From NASA-JPL conference on charge coupled device technology and applications; Washington, District of Columbia, USA (30 Nov 1976).

Twenty-four papers were presented at the conference. A separate abstract was prepared for each of 2 papers. One paper was previously abstracted under report number CONF-761117--1. The remaining 21 papers were not in scope for the data base. (WHK)

10849 (SAND—75-0485) **Bibliography: Sandia Laboratories hybrid microcircuits and related thin film technology (revised).** Oswalt, J.A. (comp.). (Sandia Labs., Albuquerque, N.Mex. (USA)). Dec 1975. Contract EY-76-C-04-0789. 91p. Dep. NTIS, PC A05/MF A01.

Hybrid circuit applications for nuclear weapons have been considered at Sandia since the mid-60's. However a major commitment was made in 1970 to develop a limited but well understood set of technologies for weapon applications. Development of these technologies and related studies have been documented in a number of publications. This bibliography lists the publications from 1968 to mid-1977 for reference by hybrid designers, users, or technologists.

10850 (SAND—77-0521) **Sandia inertial terrain-aided navigation system.** Hostetler, L.D.; Beckmann, R.C. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1977. Contract EY-76-C-04-0789. 7p. Dep. NTIS, PC A02/MF A01.

The concept of utilizing radar-derived terrain-profile data for improving the guidance accuracy of weapon delivery systems has received considerable attention in recent years in the quest of "zero" CEP. One of the more successful concepts, to date, has been the Terrain Contour Matching (TERCOM) System being developed for cruise missile applications. Basically it obtains a position fix by correlating a radar-altimeter-derived terrain profile with stored topographical data. The location of the best match is taken to be the position of the vehicle. A sequence of such position fixes is used to update an inertial navigation system (INS).

10851 (SAND—77-0726) **Accuracy limitation on strapdown calculations in a coning environment due to a given approximation to the body rate vector.** Shinkle, J.N. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1977. Contract EY-76-C-04-0789. 23p. Dep. NTIS, PC A02/MF A01.

The direction cosine matrix-differential equation $[A] = [A][\omega]$ can be solved accurately only if a precise representation of the body rate vector ω is input to the navigation computer. This paper presents an analytical solution for the limits of accuracy that can be obtained when the ω vector is extracted from polynominal fits to integrating rate sensor output data. The results are applicable to all computational algorithms.

10852 (SAND—77-1295C) **Narrow microwave pulse generation by optical enhancement of Trapatt oscillations.** Kiehl, R.A.; EerNisse, E.P. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 8p. (CONF-771201—5). Dep. NTIS, PC A02/MF A01.

From IEEE international electron devices meeting; Washington, District of Columbia, USA (5 Dec 1977).

The generation of narrow, high-power microwave pulses has been achieved by illuminating a TRAPATT diode with narrow optical pulses from a GaAlAs DH laser. Tuning the oscillator circuit to a frequency substantially above the usual operation frequency of the diode was found to result in low-level oscillation during the unilluminated portions of the TRAPATT bias pulse and a strong enhancement (up to 20 dB) of the oscillation during the optical pulse. Experimental results on the generation of 35 W pulses as narrow as 25 ns (25 RF cycles) at 1 GHz, with a rise- and fall-time of 2 ns (2 RF cycles) and excellent pulse-to-pulse stability are presented. The physical mechanism of optical enhancement is explained with results from detailed TRAPATT numerical calculations.

10853 (UCRL—52300) **On increasing the radiation efficiency of beverage-type antennas.** Miller, E.K.; Lytle, R.J.; Lager, D.L.; Laine, E.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Jul 1977. Contract W-7405-ENG-48. 22p. Dep. NTIS, PC A02/MF A01.

Previous work has shown that multiwire Beverage antennas are more efficient radiators than their single-wire counterparts. An explanation for this result, based on longitudinal current behavior, is developed and demonstrated in this presentation.

10854 **Circuit for measuring time differences among events.** Romrell, D.M. (to Energy Research and Development Administration). US Patent 4,017,794. 12 Apr 1977. Filed date 18 Sep 1975. 8p. PAT-APPL-614,404.

An electronic circuit has a plurality of input terminals. Application of a first input signal to any one of the terminals initiates a timing sequence. Later inputs to the same terminal are ignored but a later input to any other terminal of the plurality generates a signal which can be used to measure the time difference between the later input and the first input signal. Also, such time differences may be measured between the first input signal and an input signal to any other terminal of the plurality or the circuit may be reset at any time by an external reset signal.

10855 **Approximations for the symmetrical parallel-strip transmission line.** Rochelle, J.M. (Oak Ridge Natl Lab, Tenn). *IEEE Trans. Microwave Theory Tech.;* **MTT-23**: No. 8, 712-714(Aug 1975).

A single approximation that is valid for the capacitance of both "wide" and "narrow" parallel-strip transmission lines was derived by assuming that the current distribution is uniform. An approximate formula for the repulsive force between the strips was also derived.

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 9570, 9596, 9672, 9673, 10653, 10658

10856 (CONF-7605161—, pp 144-152) **Some old and new approaches to efficient fuel usage in boiler applications.** Singer, I. (Australian Gas Light Co., Sydney). 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

The origin of fossil fuels is discussed in connection with a new definition of pollution and in relation to energy. The steady state of energy flow is explained in terms of thermodynamic fundamentals. Energy usage by the living cell and its efficiency is paralleled by comparison to the burning of fuels. Some new concepts of boiler design are presented in which the flue gases cool to 35°C. The essence of this idea is the recuperation of sensible and latent heat which is currently lost to atmosphere in practically all existing boiler installations. Economic, energy, and pollution aspects are discussed in view of growing population and ever growing demands in energy. Illustrative examples and boiler concepts are discussed and explained. It is attempted in this paper to connect wider criteria with a particular topic in order to motivate experts in one field to interrelate with other fields of science when forming opinions and making decisions in their special work.

10857 (RLO/2227/T22—1) **Investigation of the rate of combustion of wood residue fuel. First annual report, April, 1976—March 31, 1976.** Junge, D.C. (Oregon State Univ., Corvallis (USA)). 18 Mar 1977. Contract EY-76-S-06-2227-022. 11p. Dep. NTIS, PC A02/MF A01.

A test facility in which to study the rate of combustion of wood residue fuels was designed and constructed. The facility has been started up and is now in process of being calibrated and made ready for data collection. The background, scope and purpose of the project are described. The test facility is illustrated photographical-

ly, schematically, and is discussed only in cursory detail. Brief discussion is offered concerning the time framework of the project, the present status of the project, list of project participants, level of financial support and an indication of the interest of agencies and industry in the efforts of this research undertaking.

UNDERGROUND ENGINEERING

REFER ALSO TO CITATION(S) 9663, 9665

10858 **Pumpable product hydraulic mining apparatus and method.** Parkes, D.M.; Hart, T.B. (to Kaiser Resources Ltd.). US Patent 4,045,086. 30 Aug 1977. Priority date 6 Apr 1976, Canada. 8p.

A method and apparatus for hydraulic mining wherein the mined product is reduced to a pumpable form are described. The apparatus includes a jet monitor for dislodging the mined product from its in situ state, a feeder-breaker for receiving the mined product, preliminarily separating the pumpable constituent of the product and then subjecting the remaining product to successive breaking and separating steps until the entire product is in a pumpable state. The feeder-breaker is also provided with a sump to collect the pumpable product and pump means to convey the product from the sump under pressure, whereby transport of the product is not dependent on gravity. In the preferred embodiment, the feeder-breaker is provided with a secondary jet monitor to reduce oversized constituents of the mined product to a size suited for the successive separating and breaking steps.

POLLUTION CONTROL EQUIPMENT

REFER ALSO TO CITATION(S) 10654, 10659

10859 (BMFT-FB-T—76-68) **Developing and testing a scrubbing procedure to purity exhausts of offensive odors.** Holtz, H.; Quillmann, H. (Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.)). Dec 1976. 30p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

The procedure to purify exhaust air by means of sodium chlorite in acid, aqueous solutions was tested in a number of different industrial firms, using a newly developed cross-current scrubber. The scrubber performed perfectly, and the individual results are positive. In one case, the procedure was successfully employed in a large scale. Work relating to controlling acid and chlorite addition via pH value and redox potential was successfully completed, and it is now possible to purify, according to this procedure, also exhaust air fluctuating in quantity and/or pollutant concentration.

STIRLING

REFER ALSO TO CITATION(S) 10583

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

10860 (COO—1805-4) **Acquisition of the ANL 4-MeV electrostatic accelerator. Progress report, September 1, 1976—August 31, 1977.** Dixon, D.R.; Hill, M.W.; Jensen, G.L. (Brigham Young Univ., Provo, Utah (USA)). 1977. Contract EY-76-C-02-1805. 12p. Dep. NTIS, PC A02/MF A01.

The operation of the Argonne 4-MeV accelerator for the reporting period from September 1, 1976 through August 31, 1977 is described. Some improvements and modifications of the accelerator and associated equipment are reported. Activities on the three research projects and a subsequent modification are summarized. An outline of work to be done in the future is given.

10861 (LA—6590) **LAMPF: the meson factory. A LASL monograph.** Allred, J.C. (Los Alamos Scientific Lab., N.Mex. (USA)). Aug 1977. Contract W-7405-ENG-36. 45p. Dep. NTIS, PC A03/MF A01.

A general and simplified introduction to the entire concept of LAMPF is given in terms of its experimental capabilities. Parts of the current experimental program are used as illustrative examples. Topics discussed include: (1) the evolution of the meson factory; (2) accelerator construction; (3) strong focusing; (4) accelerator innovations at LAMPF; (5) photons and pions; (6) muons as nuclear probes; (7) nuclear chemistry; (8) radiobiology and medical applications; (9) radioisotope production; (10) materials testing; and (11) LAMPF management and users group. (PMA)

10862 (LA—6878-MS) **LAMPF: a nuclear research facility.** Livingston, M.S. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36. 86p. Dep. NTIS, PC A05/MF A01.

A description is given of the recently completed Los Alamos Meson Physics Facility (LAMPF) which is now taking its place as one of the major installations in this country for the support of research in nuclear science and its applications. Descriptions are given of the organization of the Laboratory, the Users Group, experimental facilities for research and for applications, and procedures for carrying on research studies.

10863 (LA—6938-PR) **Medium-energy physics program. Progress report, February 1—April 30, 1977.** van Dyck, O.B.; Dunn, E.D. (comps.). (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36. 93p. Dep. NTIS, PC A05/MF A01.

Operations and research programs at the LAMPF Linac are reported for February, March, and April, 1977. The contents include: (1) a summary and a list of recent publications; (2) accelerator operations; (3) injector systems; (4) accelerator systems development; (5) accelerator support; (6) engineering support; (7) electronic instrumentation and computer systems; (8) beam line development; (9) experimental areas; (10) large-spectrometer systems; (11) practical applications of LAMPF; (12) linac technology; (13) nuclear chemistry; (14) research; and (15) management. (PMA)

10864 (LBL—5540) **Bevalac Minibeam Facility.** Schimmerling, W.; Alonso, J.; Morgado, R.; Tobias, C.A.; Grunder, H.; Upham, F.T.; Windsor, A.; Armer, R.A.; Yang, T.C.H.; Gunn, J.T. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1977. Contract W-7405-ENG-48. 4p. (CONF-770313—74). Dep. NTIS, PC A02/MF A01.

From Particle accelerator conference; Chicago, Illinois, USA (16 Mar 1977).

The Minibeam Facility is a biomedical heavy-ion beam area at the Bevalac designed to satisfy the following requirements: (1) provide a beam incident in a vertical plane for experiments where a horizontal apparatus significantly increases the convenience of performing an experiment or even determines its feasibility; (2) provide an area that is well shielded with respect to electronic interference so that microvolt signals can be detected with acceptable signal-to-noise ratios; (3) provide a beam of small diameter, typically a few millimeters or less, for various studies of cellular function; and (4) provide a facility for experiments that require long setup and preparation times and apparatus that must be left relatively undisturbed between experiments and that need short periods of beam time. The design of such a facility and its main components is described. In addition to the above criteria, the design was constrained by the desire to have inexpensive, simple devices that work reliably and can be easily upgraded for interfacing to the Biomedical PDP 11/45 computer.

10865 (SAND—77-1282C) **Design and development of a 350 kV, 100 pps electron beam accelerator.** Rohwein, G.J.; Buttram, M.T.; Prestwich, K.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. 24p. (CONF-771035—10). Dep. NTIS, PC A02/MF A01.

From 2. international topical conference; Ithaca, New York, USA (3 Oct 1977).

A 350 kV, 300 J/pulse, 100 pulse/sec electron beam accelerator was designed and constructed. A description of the physical features of the machine is included along with performance data from the initial operation of the system.

10866 (SAND—77-1551C) **Ion acceleration in a moving virtual cathode.** Miller, R.B. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 28p. (CONF-771035—4). Dep. NTIS, PC A03/MF A01.

From 2. international topical conference; Ithaca, New York, USA (3 Oct 1977).

When an intense electron beam is injected into an evacuated drift cavity placed in a strong longitudinal magnetic field a virtual cathode will form if the beam current exceeds the space charge limiting current. If the drift tube is flared, the virtual cathode can form a substantial distance downstream from the injection plane, and will propagate backward toward the injector, depending upon the time dependent diode voltage and current waveforms. In a recent series of experiments a small amount of neutral gas was introduced into the drift tube and acceleration of gas ions was observed to occur, also in a direction backward toward the injection plane. The acceleration occurs over a very narrow pressure range (2 to 8 x 10^{-4} torr for H_2 and D_2), and can be entirely suppressed by reducing the magnetic field strength. Using a 2 MeV, 20 kA electron beam, nuclear activation of thin (1 mil) anode foils was observed for a number of different reactions, including $^{12}C(d,n)^{13}N$ and $^{63}Cu(d,2n)^{63}Zn$ for deuterons, and $^{47}Ti(p,n)^{47}V$ and $^{63}Cu(p,n)^{63}Zn$ for protons.

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

10867 (LA-UR—77-1320) **Finite element analysis of the axisymmetric electromagnetic oscillations in the PHERMEX machine.** Fugelso, E.; Cook, W.A. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 18p. (CONF-770813—2). Dep. NTIS, PC A02/MF A01.

From ADINA conference; Cambridge, Massachusetts, USA (4 Aug 1977).

The calculation of the electromagnetic field, characteristic frequency, and loss factors for the TM_{010} mode of operation of the PHERMEX machine, a three-cavity, linear electron accelerator, were carried out using the finite element method. Perturbations from the simple, closed cylindrical shape cause changes in the electromagnetic field distribution and in the fundamental frequency, which will affect the electron-beam dynamics and the energy transfer to the beam. Cavity loss factors are essentially unaltered.

10868 (LA-UR—77-2205) **Relativistic electron beam cyclotron wave growth in helical slow wave structures.** Godfrey, B.B.; Faehl, R.J.; Newberger, B.S.; Shanahan, W.R.; Thode, L.E. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 13p. (CONF-771035—8). Dep. NTIS, PC A02/MF A01.

From 2. international topical conference; Ithaca, New York, USA (3 Oct 1977).

One of the more promising and thoroughly studied proposals for high energy collective ion acceleration is Autoresonant Acceleration: Ions trapped in the electrostatic wells of large amplitude slow cyclotron waves in an unneutralized intense relativistic electron beam are accelerated by the increase of wave phase velocity as the beam propagates along a magnetic guide field of decreasing strength. A critical component of this scheme is growth of coherent, large amplitude waves. A discussion is given of wave growth by interaction of the beam with a helical slow wave structure. Specific topics include: (1) equilibrium charge and current distributions on the helix; (2) linear wave growth spectra including the effects of radial inhomogeneity; (3) wave growth and saturation; and (4) extraction of cyclotron waves from the amplifier cavity. Movies of two-dimensional computer simulations were made. It was found that waves of amplitude adequate for planned feasibility experiments can indeed be obtained.

AUXILIARIES AND COMPONENTS

10869 (LA—6959-MS) **Wire-scanner recentering experiment error estimates.** Swain, G.R. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36. 25p. Dep. NTIS, PC A02/MF A01.

In the wire-scanner recentering experiment, the effective center of a wire scanner is determined by turning the previous quadrupole magnet on and off. The beam is steered into the quadrupole such that it drifts to the same point somewhere on a second wire scanner downstream, for the quadrupole both on and off. With this steering, the beam is assumed to be centered at the quadrupole and first wire scanner. Approximate formulas and more exact numerical calculations show that for any incoming position at the quadrupole (not just the center), there is a corresponding incoming angle such that the beams for the quadrupole on and off will drift to the same point. Errors in the recentering experiment of 9 to 13 February 1977 due to the beams not converging to exactly the same point and due to the convergence point being off axis are estimated to be 0.8 mm or less. Errors from quadrupole angular misalignments are estimated to be 0.5 mm or less.

10870 **Superconducting dipole electromagnet.** Purcell, J.R. (to Energy Research and Development Administration). US Patent 4,038,622. 26 Jul 1977. Filed date 13 Apr 1976. 8p.

PAT-APPL-676,585.

A dipole electromagnet of especial use for bending beams in particle accelerators is wound to have high uniformity of magnetic field across a cross section and to decrease evenly to zero as the ends of the electromagnet are approached by disposing the superconducting filaments of the coil in the crescent-shaped nonoverlapping portions of two intersecting circles. Uniform decrease at the ends is achieved by causing the circles to overlap increasingly in the direction of the ends of the coil until the overlap is complete and the coil is terminated.

10871 **Touch panel system for control applications.** Crook, K.; Johnson, R. (Stanford Univ., CA). pp 281-287 of In Digital computer applications to process control. Van Nauta Lemke (ed.). Amsterdam; North-Holland Publishing Co. (1977).

The use of finger-sensitive touch panels in association with computer-generated displays for control and monitoring of the Stanford linear accelerator is discussed. This control concept has proven to be very effective. The hardware and software aspects of the Touch Panel portion of the control system are described.

ION SOURCES

10872 **Realization of acceleration of laser-injector-generated carbon nuclei in the synchrophasotron at the Joint Institute for Nuclear Research.** Anan'in, O.B.; Baldin, A.M.; Beznogikh, Y.D.; Bykovskii, Y.A.; Govorov, A.I.; Zinov'ev, L.P.; Kozyrev, Y.P.; Makarov, L.G.; Monchinskii, V.A.; Novikov, I.K.; Peklenkov, V.D.; Raspopin, A.M.; Semenyushkin, I.N. (Engineering-Physics Institute, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* 7: No. 7, 873-874(Jul 1977).

A report is given of the acceleration to subrelativistic energies of carbon nuclei generated in a trial run of a laser injector of multiply charged ions and nuclei attached to the synchrophasotron at the Joint Institute for Nuclear Research.

EXPERIMENTAL FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 11391

STORAGE RINGS

REFER ALSO TO CITATION(S) 10877

10873 (LBL—6161) **Structural support system for a superconducting magnet coil.** Meuser, R.B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 3 Mar 1977. Contract W-7405-ENG-48. 11p. (CONF-770326—1). Dep. NTIS, PC A02/MF A01.

From Western regional strain gage committee meeting; San Jose, California, USA (3 Mar 1977).

The purpose of the ESCAR (Experimental Superconducting Accelerator Ring) project, now under way at the Lawrence Berkeley Laboratory, is to gather data and experience in the design and operation of a relatively small synchrotron employing superconducting magnets. Such data are essential to ensure that the design of future large accelerators may proceed in a knowledgeable and responsible manner. One of the many engineering problems associated with a superconducting magnet is the design of the coil suspension system. The coil, maintained at the temperature of liquid helium, must be held rigidly by a structure that does not conduct too much heat into the liquid helium system. The suspension system used on the ESCAR magnets is described. Topics covered include the coil support system requirements, ESCAR magnet support system, and operating experience.

INSTRUMENTATION

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 10133, 10336, 10398, 10989, 11168

10874 **Development of a new scintillator containing uranium.** Catalano, E.; Czirr, J.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Nucl. Instrum. Methods;* **143**: No. 1, 61-62(15 May 1977).

A prototype fission detector has been built and its performance measured. This detector, based on an inorganic solid-solution single-crystal scintillator containing uranium, provides several advantages over parallel-plate fission chambers: an order-of-magnitude improvement in uranium-to-substrate ratio, no fission-fragment losses, and ease of construction.

10875 **Low-background plutonium assaying using a modified commercial liquid scintillation detector and sample changer.** Hiebert, R.; Ide, H.; Boyd, H. (Los Alamos Scientific Lab., N.Mex. (USA)). *Health Phys.;* **32**: No. 4, 311-313(Apr 1977).

A low-background plutonium alpha assaying system is described that uses a standard commercial liquid scintillation sample auto-changer and shield assembly with minimal pulse shape discrimination electronics to achieve good counting performance with mass-sample assay capability. A block diagram of the detectors and electronics employed is shown and the performance of the system discussed.

10876 **Mosaic intrinsic germanium radioisotope scanning device with longitudinal section scanning capability.** Patton, J.A.; Price, R.R.; Brill, A.B. (Vanderbilt Univ., Nashville, Tenn. (USA). Medical Center); Pehl, R. (California Univ., Berkeley (USA). Lawrence

Berkeley Lab.). pp 159-169 of In Medical radionuclide imaging. Vienna; International Atomic Energy Agency (1977).

From International symposium on medical radionuclide imaging; Los Angeles, Calif., USA (25 - 29 Oct 1976).

A nine-element array of high purity germanium detectors has been designed and fabricated as a high resolution scanning device to be used in conjunction with radioisotopes in diagnostic studies in nuclear medicine. The detectors are 35 mm in diameter by 10 mm thick and are positioned in a 3 x 3 array with 50 mm between the centres. The energy resolution of the detectors ranges from 1.06 to 1.18 keV at 140 keV. The crystals and associated electronics are very closely matched with a maximum deviation in sensitivity of 18% from the average with collimation. The system is suspended over a computer-driven scanning bed and will remain stationary while the patient is moved in an x-y raster beneath the collimated detectors. Data are collected in a PDP-11 computer interfaced via CAMAC with capability for 2 SCA windows per detector for multiple isotope studies. Collimators are available for routine frontal plane scanning and longitudinal section tomography. The sensitivity of the system should be sufficient to permit an adequate study of the capabilities of a semiconductor scanning system in a routine clinical environment.

RADIATION DOSEMETERS

REFER ALSO TO CITATION(S) 10421

HIGH ENERGY PHYSICS INSTRUMENTATION

10877 (ANL-HEP-PR—77-53) **Long-lived particle spectrometer for the Fermilab collider.** Ayers, D.S.; Diebold, R. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 10p. Dep. NTIS, PC A02/MF A01.

An updated design is described for the large-angle spectrometer previously described in the 1976 Fermilab Summer Study. The primary objective of the device is to search for heavy stable (tau greater than or equal to 10^{-8} sec) particles by direct measurements of momentum, time-of-flight, energy deposition in a calorimeter, multiple dE/dx samples, and Cerenkov counter information. These quantities determine the charges and masses of stable particles which traverse the spectrometer, and provide a sensitive means of discovering new heavy objects.

10878 **Study of drift chamber system for a K-e scattering experiment at the Fermi National Accelerator Laboratory.** Filatova, N.A.; Nigmanov, T.S.; Pugachevich, V.P.; Riabtsov, V.D.; Shafranov, M.D.; Tsyganov, E.N.; Uralskii, D.V.; Vodopianov, A.S. (Joint Inst. for Nuclear Research, Dubna (USSR)); Sauli, F. (European Organization for Nuclear Research, Geneva (Switzerland)); Atac, M. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). *Nucl. Instrum. Methods;* **143**: No. 1, 17-28(15 May 1977).

A drift chamber system is described for a K-e elastic scattering experiment, to be done at Fermilab, using a 250 GeV/c kaon beam. The chambers were built at JINR, Dubna, and tested at Fermilab using a 150 GeV/c pion beam. An average spatial accuracy of about 60 μm at low beam intensity was obtained. Drift chamber efficiencies at different beam intensities are presented. The average efficiency was more than 0.98 at an intensity of 0.5×10^6 particles per spill with a fwhm beam size of about 20 mm. The dependence of drift chamber accuracy on anode high voltage and beam intensity was also studied.

10879 **First observations of particle tracks in condensed matter by an emission method.** Bolozdynya, A.I.; Egorov, O.K.; Korshunov, A.A.; Miroshnichenko, V.P.; Rodionov, B.U.; Sokolov, L.I.; Sosnovtsev, V.V. (Moscow Engineering-Physics Institute). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 9, 375-378(5 May 1977).

The operating conditions are described and photographs are presented of particle tracks obtained by an emission method in crystalline krypton.

RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS

10880 (N—77-14540, pp 110-114) **Effects of neutron irradiation on the characteristics of a buried channel CCD at 80°K and 295°K.** Saks, N.S.; Killiany, J.M.; Baker, W.D. (Naval Research Lab., Washington, DC). 1976.

From NASA-JPL conference on charge coupled device technology and applications; Washington, District of Columbia, USA (30 Nov 1976).

In Proceedings of conference on charge-coupled device technology and applications.

Buried channel CCD shift registers have been irradiated with 15 MeV (average energy) neutrons in steps to 3×10^{13} n/cm². The irradiations were performed at 80°K and 295°K on operating devices with normal clocks and bias voltages applied. Dark current increased from the pre-irradiation value of 7 nA/cm² to 1600 nA/cm² at 1×10^{13} n/cm². The input gate threshold shift observed at 80°K was -0.9 volts per 10^{13} n/cm², a factor of 4 less than that predicted from a first-order calculation of the equivalent ionization dose of neutrons in the oxide. Transfer efficiency measurements yield a bulk electron trap creation rate for neutron irradiation (ΔN/sub t//Δ phi) of 14.0 cm^{-1} at 295°K with a trap emission time constant of 25 μs. At 80°K, the trap creation rate is 2.0 cm^{-1} with an emission time constant of 100 ms.

10881 (SAND—77-0870C) **Radiation-hardening of MOS structures.** Derbenwick, G.F. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 17p. (CONF-770848—1). MF A01.

From IEEE non-volatile semiconductor memory workshop; Vail, Colorado, USA (23 Aug 1977).

Characteristic graphs are presented for radiation hardened MOS structures for electron-hole pair yield, voltage—capacitance, oxide thickness—ΔV, and anneal temperature—ΔV. (WHK)

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 9544, 9545, 9551, 9567, 9568, 9597, 9598, 9599, 9617, 9683, 9692, 9695, 9764, 10170, 10194, 10337, 10341, 10342, 10371, 10373, 10379, 10623, 10761, 10848, 10908, 10976, 11006

10882 (BDX—613-1566) **Laboratory automatic data acquisition system.** Schantz, L.E. (Bendix Corp., Kansas City, Mo. (USA)). Sep 1977. Contract EY-76-C-04-0613. 85p. Dep. NTIS, PC A04/MF A01.

A laboratory automatic data acquisition system (ADAS) has been established in the electronic products laboratory. The system consists of three basic blocks: the software control calculator, which controls the entire system, receives data from the system, and acts upon it in some intelligent manner; a variety of laboratory measuring equipment which gathers data and inputs it in BCD format; and the coupler/controller-and-patch-panel combination which makes it possible for BDC information from the gathering apparatus to be transmitted to the calculator. Approximately 50 software programs have been written for the system, including one which permits the ADAS system to scan resistors, measure their values, record the values, and permit the percent change in resistor values to be plotted. A program has also been written for data on temperature coefficients of resistance on thin film resistors.

10883 (CONF-770935—2) **Polarization produced by grazing-incidence monochromators.** Arakawa, E.T.; Williams, M.W. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 4p. Dep. NTIS, PC A02/MF A01.

From 5. international conference on vacuum ultraviolet radiation physics; Montpellier, France (5 Sep 1977).

The grating in a monochromator introduces some polarization into the optical beam, the amount depending on the geometry of the system and on the type of grating. A knowledge of this polarization is important, whether the monochromator is used for the spectral analysis of an experimental source of electromagnetic radiation or to produce monochromatic radiation for optical or photoelectric yield experiments. Since it cannot, at this time, be calculated theoretically it is necessary to measure directly the polarization introduced by the grating. The polarization introduced by various gratings used in the Seya-Namioka geometry was previously measured. These observations are extended to a grazing-incidence geometry which is employed in grazing-incidence monochromators to obtain spectra to smaller wavelengths than is possible with a Seya-Namioka monochromator.

10884 (LA—6965-MS) **Effect of attitude control thruster induced structural vibrations on sensed accelerations of a space vehicle.** Butler, T.A. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36. 41p. Dep. NTIS, PC A03/MF A01.

The response of a miniature electrostatic accelerometer (MESA) to the structural vibrations of a space vehicle (SV) is determined analytically. Knowledge of these vibration-induced accelerations will be used to interpret the total MESA accelerations that will be obtained while the SV is in orbit. Equations of motion containing nonlinear terms are solved to show that a linear analysis approach will yield sufficient accuracy. A Laplace transform technique is then used to solve the linearized equations, which are decoupled using the normal vibration modes of the SV. A computer program is developed to solve the equations of motion. It includes frequency attenuation and sampling interval characteristics of the MESA and equivalent viscous damping for the SV vibratory modes. The calculated MESA response to 1800 s of actual thruster excitation is presented. The calculated results show that the MESA

electronic filter effectively eliminates accelerations from high frequency SV motion. The use of the first two normal modes of vibration to calculate the response results in accuracies that are within the resolution of the MESA. However, the response is shown to be sensitive to the equivalent viscous damping values chosen for these two modes. The computer program is specifically designed to treat excitation from the control system thrusters, but with minor program changes other types of excitation can be accommodated.

10885 (MHSMP—77-5G) **Small inner spherical radius sweep gage. Period covered: October—December 1976. Final report.** Black, L.W. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1977. Contract EY-76-C-04-0487. 5p. Dep. NTIS, PC A02/MF A01.

A gage designed for sweeping a small (under 12 mm) inner spherical radius using a common full bridge strain gage (two active gages) as a sensing transducer is described.

10886 (UCRL-Trans—11270) **Optical branch for multimode systems.** Witte, H.H. Translated from *Opt. Commun.;* **18**: No. 4, 559-562(1976). 12p. Dep. NTIS, PC A02/MF A01.

An optical branching structure for multimode fibers is discussed. Its characteristic properties are simple fabrication, repoducibility and dimensional stability and high coupling efficiency. The mode of operation of the branch is based on the lateral displacement of two fibers arranged flush to each other. The size of the displacement determines the fraction of power branched off. With fibers of 100 microns outer diameter and 90 microns core diameter, a coupling efficiency of approximately 74% was measured at a lateral displacement of 15 microns. Of the arriving power, 73% continued along the main channel and approximately 1% was branched off. A diagram is given from which the coupling efficiencies can be read as a function of lateral displacement. 3 figures.

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

REFER ALSO TO CITATION(S) 9666

10887 (MHSMP—77-5E) **Formulation and process safety, October—December 1976. Endeavor No. 216.** West, G.T. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1976. Contract EY-76-C-04-0487. 4p. Dep. NTIS, PC A02/MF A01.

Additional shock tests were performed on TATB/water mixtures. Testing completed to date has included 100, 94, 85, 80, 75 and 70 wt % TATB. In the geometry tested, TATB/water mixtures fail to detonate at or below 75% TATB, and detonate at or above 80% TATB.

10888 (MHSMP—77-24) **Chlorine free synthesis of TATB.** Estes, Z.L. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Jul 1977. Contract EY-76-C-04-0487. 6p. Dep. NTIS, PC A02/MF A01.

The principal objective of this endeavor is to produce TATB that is free of the potentially corrosive ammonium chloride. Previous attempts to synthesize a chlorine free precursor to TATB have resulted in difficult to separate mixtures which are the result of side reactions. A new variation of the present process has been tried on a laboratory scale which appears to produce TATB with one to two orders of magnitude less ammonium chloride than the standard process. Several other possible synthesis routes to totally chlorine free TATB were tried without success.

10889 (MHSMP—77-25) **Trichloronitrosobenzene: a raw material for TATB synthesis.** Estes, Z.L. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Jul 1977. Contract EY-76-C-04-0487. 5p. Dep. NTIS, PC A02/MF A01.

In the usual synthesis of s-triaminotrinitrobenzene (TATB), s-trichlorobenzene (TCB), is first nitrated to s-trichlorotrinitrobenzene (TCTNB) and then aminated with ammonia. The s-TCB is obtained as a byproduct from another synthesis operation or from 2,4,6-trichloroaniline. Isomerization of 1,2,4-trichlorobenzene is another possible source. Eastman Chemical Company (Kingsport, Tennessee) is a large producer of 2,4,6-trichloroaniline (TCA) which is used in the synthesis of photographic chemicals; however, they are unwilling to convert this to either the s-TCB or trichloronitrobenzene due to environmental concerns. They have proposed instead to convert TCA to 1,3,5-trichloro-2-nitrosobenzene in large quantity.

10890 (MHSMP—77-50) **Evaluation of gas volumes evolved during vacuum stability testing of HNS. Period covered: October—December 1976.** Sandoval, J. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1976. Contract EY-76-C-04-0487. 11p. Dep. NTIS, PC A02/MF A01.

The study was undertaken to determine the effect of dipicrylethane, a common impurity in HNS, on the volume of volatiles evolved during HNS vacuum stability measurements, and to evaluate the repeatability of results obtained during this testing.

10891 (SAND—74-0112) **Synthesis of symmetrical trichlorotrinitrobenzene. Part 1. Nitrations with alkali metal nitrates.** O'Keefe, D.M.; Gurule, F.T. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jun 1977. Contract EY-76-C-04-0789. 27p. Dep. NTIS, PC A03/MF A01.

Trichlorotrinitrobenzene (TCTNB) is an intermediate in the synthesis of the insensitive explosive, TATB. TCTNB is made by the nitration of sym-trichlorobenzene. This nitration produces two by-products in addition to the desired TCTNB. The variables of this reaction has been studied to learn how to minimize by-product formation. The parameters studied include the organic starting material, nitrating agent, sulfuric acid, time and temperature of the reaction, sulfonation, and recrystallization.

10892 (SAND—77-0852) **Gold—indium diffusion in bridgewires.** Harwood, W.D. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1977. Contract EY-76-C-04-0789. 25p. Dep. NTIS, PC A02/MF A01.

A study being directed toward refining previous estimates of the rate of diffusion of indium into gold and of gold into lead-tin-indium solder under the conditions existing in gold bridgewire detonators is described. The study is also concerned with the effects of gold-indium intermetallic compound on the performance of detonators and methods which can determine the condition of bridgewires. The study has verified that such diffusion progresses even under room-temperature storage conditions. Data generated indicate that heavily diffused bridgewires can be recognized by characteristic anomalies in both the current and voltage firing waveforms. In addition it appears that nondestructive test techniques can be used to identify potentially failing units before degradation progresses to the point of failure.

10893 Method for the production of high-purity triaminotrinitrobenzene. Benziger, T.M. (to Energy Research and Development Administration). US Patent 4,032,377. 28 Jun 1977. Filed date 19 Jul 1976. 4p.

PAT-APPL-706,403.

Triaminotrinitrobenzene is readily formed by the nitration of 1,3,5-trichlorobenzene to 1,3,5-trichloro-2,4,6-trinitrobenzene followed by amination to triaminotrinitrobenzene. The purity of the triaminotrinitrobenzene is significantly improved if, during the amination step, sufficient water is present that the byproduct ammonium chloride formed during the amination is rendered at least semideliquescent.

10894 Ammonium 2,4,5-trinitroimidazole. Coburn, M.D. (to Energy Research and Development Administration). US Patent 4,028,154. 7 Jun 1977. Filed date 1 Sep 1976. 2p.

PAT-APPL-719,636.

The chemical explosive, ammonium 2,4,5-trinitroimidazole, has explosive performance comparable to that of the well-known RDX, but a thermal stability which is significantly greater.

NUCLEAR

REFER ALSO TO CITATION(S) 10961, 11021

10895 (LA—6946-MS) **Performance of electrical contact pins near a nuclear explosion.** Ragan, C.E.; Silbert, M.G.; Ellis, A.N.; Robinson, E.E.; Daddario, M.J. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36. 13p. Dep. NTIS, PC A02/MF A01.

The pressures attainable in equation-of-state studies using nuclear-explosion-driven shock waves greatly exceed those that can be reached in normal laboratory conditions. However, the diagnostic instrumentation must survive in the high-radiation environment present near such an explosion. Therefore, a set of experiments were fielded on the Redmud event to test the feasibility of using electrical contact pins in this environment. In these experiments a 60-cm-high shield of boron-lead was placed on the rack lid approximately 1 m from the device. A sample consisting of slabs of molybdenum and ^{238}U was placed on top of the shield, and twelve electrical contact pins were embedded to five different depths in the materials. Five different multiplexing-charging circuits were used for the pins, and a piezoelectric quartz gauge was placed on top of the uranium to obtain an estimate of the fission-energy deposition. All of the charged pins survived the radiation and produced signals indicating shock arrival. The uncertainty in determining the pin-closure time was approximately 3 ns. The signal from the quartz gauge corresponded to a pressure that was consistent with the calculated neutron fluence.

10896 (N—77-14540, pp 145-151) **High speed imaging system for nuclear diagnostics.** Eyer, H.H. (Univ. of California, Livermore). 1976.

From NASA-JPL conference on charge coupled device technology and applications; Washington, District of Columbia, USA (30 Nov 1976).

In Proceedings of conference on charge-coupled device technology and applications.

A high speed imaging system based on state-of-the-art photosensor arrays has been designed for use in nuclear diagnostics. The system is comprised of a front-end rapid-scan solid-state camera, a high speed digitizer, and a PCM line driver in a downhole package and a memory buffer system in an uphole trailer. The downhole camera takes a "snapshot" of a nuclear device created flux stream, digitizes the image and transmits it to the uphole memory system before being destroyed. The memory system performs two functions: it retains the data for local display and processing by a microprocessor, and it buffers the data for retransmission at slower rates to the LLL computational facility (NADS). The impetus for such a system as well as its operation is discussed. Also discussed are new systems under development which incorporate higher data rates and more resolution.

CIVIL USES

REFER ALSO TO CITATION(S) 9666

10897 (PNE-R—68) **Rulison: radiation contamination clearance report.** (Eberline Instrument Corp., Santa Fe, N.Mex. (USA)). Jun 1977. 53p. Dep. NTIS, PC A04/MF A01.

Under contract with Austral Oil Company, Eberline Instrument Corporation provided supervision and technicians to radiologically support the well plugging and site abandonment activities at the Project Rulison site during the period September 1, 1976 through October 12, 1976. The purpose of the support was to identify and prepare for removal of all radioactively contaminated materials remaining on site. The emplacement and reentry wells were successfully plugged without a serious radiological incident. There was no measurable radiation exposure above natural background to participating personnel. Decontamination and monitoring procedures assured that no equipment or material was improperly released to unrestricted use. A review of the history of project operations, the conduct of comprehensive sampling programs, and an extensive final survey, ensures that the extent of radioactivity on the site is identified and that such activity is well below established guide lines. Except for appropriate restrictions regarding deep drilling, the radiological condition of the Project Rulison site permits its return to unrestricted use.

WEAPONRY

REFER ALSO TO CITATION(S) 11163

EXPLOSION DETECTION

10898 **Nuclear explosion detector with false alarm prevention.** Frungel, F. US Patent 4,044,258. 23 Aug 1977. Priority date 30 Dec 1970, German, Federal Republic of (F.R. Germany). 8p.

An antenna receives electromagnetic radiation and furnishes a corresponding signal which after differentiation sets a first monostable multivibrator whose output lasts for several microseconds. A photodiode receives light signals. If the light signals are received within the time that the first monostable multivibrator is set, the generation of an alarm is inhibited, since substantially simultaneous reception of electromagnetic and light signals indicates either atmospheric disturbance or conventional weapons. In the absence of an inhibit signal, a second multivibrator is set for several milliseconds at the end of the setting of the first multivibrator. Any light received while the second multivibrator is set results in the furnishing of an alarm.

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

10899 (DP—1455, pp 177-178) **Digitization of acoustic sounder data.** Schubert, J.F. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

A method of archiving acoustic sounder data in a format compatible with a computer is used development. The collected data will be used to compile a climatology of the atmospheric surface boundary layer to predict the transport and diffusion of atmospheric pollutants.

10900 (DP—1455, pp 223-224) **Status of weather information and display (WIND) system.** Mueller, R.A.; Kern, C.D. May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

The Environmental Transport Division (ETD) conducts an extensive program of research on atmospheric transport and dispersion. At the same time, ETD personnel provide improvements to the emergency meteorological response to accidental releases into the atmosphere. Support of this program requires acquisition and archiving of current meteorological data on a regional basis both near the Savannah River Plant (SRP) and throughout the southeastern United States. The Weather Information and Display (WIND) minicomputer system enables scientists to have at their disposal these archived data which provide input to a number of research activities. The WIND system contains programs which calculate transport and dispersion rapidly and displays the results in tabular and graphic form. These programs improve the basis for management decisions during an accidental release of pollutants to the atmosphere.

10901 (DP—1455, pp 229-230) **Computer code to generate population grids for various geographies.** Cooper, R.E. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

The Environmental Transport Division at the Savannah River Laboratory (SRL) is engaged in studies which require gridded population data to estimate environmental effects of various pollutants released to the environs. Although the major concern at SRL is the ultimate fate and environmental effects of materials released from the Savannah River Plant, some studies pertain to other regions of the contiguous United States. The studies may also involve various grid shapes which require the ability to generate population data for a wide variety of situations. A computer code, PODGE, was written to provide this capability. The basic requirement of PODGE is a large population data base from which to operate. This requirement is fulfilled by the acquisition of a data base from the Oak Ridge National Laboratory (ORNL) RUSTIC program. These data, covering the United States, are organized into geographic areas (defined by increments of longitude and latitude) for various grid sizes. The PODGE code reorganizes these data to conform to various grids as described below. All grids are defined by an n x m array of coordinate pairs (longitude and latitude), which are automatically generated by the PODGE code with one exception, which involves totally arbitrary coordinates. PODGE is operational under the SRL JOSHUA system. As population grids are generated as a result of specific requirements, they are stored as named records within the JOSHUA system and kept available for future use.

10902 (DP—1455, pp 237-238) **Development of a generalized environmental data base extraction and graphical display system.** Suich, J.E. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

The JOSHUA data management system is being extended to accommodate the characteristics typical of environmental data bases. At the present time, the capabilities permit the retrieval of a subset of records from the data base and their graphical display on a cathode ray tube. In the future, context-dependent modules will be written to include the conventions of the several environmental science disciplines.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 9595, 9596, 9655, 10940, 11376

10903 (CONF-7605161—, pp 334-344) **Air pollution in Melbourne and control of motor vehicle emissions.** Lau, W.W.P. (Environment Protection Authority, Victoria, Australia). 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

The brown haze that is frequently observed in Melbourne during calm and sunny days has been identified to be the result of photochemical air pollution. Monitoring data combined with an emission inventory have provided a clear indication that motor vehicle emissions are the major sources of the precursors. Many emission control methods are available to the vehicle manufacturers. Overseas experience has shown that the Australian 1976 standards can be met easily and economically and that the weight of a vehicle is the most important factor governing emission quality and fuel economy.

10904 (DP—1455, pp 103-104) **Use of fluorescence microscopy in algal studies.** Wilde, E.W. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

The identification and enumeration of phytoplankton and periphytic algae is aided at the Savannah River Laboratory (SRL) by the use of fluorescence microscopy. The ability of chlorophyll to emit fluorescent light is a phenomenon which has been utilized for many years in algal studies involving chlorophyll extraction, but has only recently been applied to studies involving microscopic examinations. Fluorescence microscopy has several advantages over conventional light microscopy. Distinctive exposure of chlorophyll pigments is helpful in differentiating between cells which were alive at the time of collection and those which were dead. Species identifications are facilitated by clear observations of the size and shape of chloroplasts in eucaryotic algae. The diffuse nature of the chlorophyll in blue-green algae can also be clearly observed. Sample analysis time can be greatly reduced, as only the chlorophyll-bearing cells appear bright in the field of view. Fluorescence microscopy is especially advantageous when samples containing substantial quantities of silt and detritus are analyzed, because obstructed specimens can be observed. However, chlorophyll-bearing diatoms which cannot be accurately identified during counting with the fluorescence technique require acid-cleaned hyrax preparations for species identification and diatom proportional counts.

10905 (DP—1455, pp 215-218) **Smoke dispersal from a controlled fire in logging debris over a cleared pine forest area.** Murphy, C.E. Jr. (Savannah River Lab., Aiken, SC); Sigmon, J.T.; Williams, D.T.; Ryan, P.W.; McNab, W.H. May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

The dispersion of smoke in the atmosphere was studied during a controlled fire of forest debris on the Savannah River Plant. The objectives of the research were to provide a data base for testing models of smoke dispersion, and improve understanding and prediction capabilities for dispersion of atmospheric pollutants in general. An instrumented aircraft measured smoke density and other parameters in multiple traverses through the smoke plume. The data permitted contour maps of constant smoke density to be drawn in three dimensions. Centerline smoke density reached a maximum of 0.43 $\mu g/m^3$. Supporting meteorological data were taken at an array of towers (7 towers, each 62 meters high) near the fire, and at different elevations on a TV tower (400 meters high) located 35 km from the site of the fire. Preliminary analysis of the data indicates that the simple Gaussian plume model with an effective stack height does not predict the smoke pattern. This may be caused by "leakage" from the plume or by multiple sources associated with parts of the burned area being at different stages of fire activity.

10906 (DP—1455, pp 239-240) **Initial development of the JEREMIAH system for simulation of pollutant transport in the environment.** Buckner, M.R. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

A modular environmental transport and dose computational system is being developed to provide emergency and routine response capabilities for environmental assessment of pollutant releases at the Savannah River Plant (SRP). The system is called JEREMIAH (JOSHUA Emergency and Routine Environmental Impact Assessment Handler) and operates under the JOSHUA system. The JOSHUA system provides extensive data management facilities and convenient programming interfaces for modular structuring. The initial JEREMIAH system handles atmospheric pollutant releases from SRP as well as from other nuclear facilities in the southeastern United States.

10907 (DP—1455, pp 241-246) **Modeling the dispersion of atmospheric pollution using cubic splines and chapeau functions.** Pepper, D.W.; Long, P.E.; Kern, C.D. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Knowledge of the inaccuracies inherent in each method are necessary prior to their use in modeling the dispersion of atmospheric pollutants. The accuracy and amount of artificial diffusion and dispersion of each method can be easily visualized by conducting a simple test: A cosine hill distribution of concentration with a peak value of 100 is advected in a clockwise direction. The peak value and distribution should remain constant throughout the rotation. Hence, a measure of the accuracy of a method lies in its ability to transport the distribution without change. This test was used by Long and Pepper in analyzing six numerical schemes for advecting pollutant concentrations. A part of their analysis is shown here.

10908 (SAND—77-0601) **Tunable diode laser heterodyne spectrometer for balloon-borne solar radiometry in the stratosphere.** Hackett, C.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Apr 1977. Contract EY-76-C-04-0789. 46p. Dep. NTIS, PC A03/MF A01.

A wavelength tunable infrared laser heterodyne spectrometer was taken into the stratosphere as part of the instrumentation package on board the stratospheric scientific research balloon, STRATCOM VI, in order to obtain high-resolution atmospheric absorption spectra of nitric oxide and water vapor by measurement of the attenuation of the solar radiance at approximately 5.24 microns. This report describes the development of this instrument system and the experimentation that characterized its performance.

10909 **Global chemical cycles and their alterations by man.** Stumm, W. (ed.). Berlin; Abakon Verlagsgesellschaft (1977). 347p. (CONF-761184—).

From Workshop on global chemical cycles and their alterations by man; Berlin, F.R. Germany (15 Nov 1976).

Separate abstracts were prepared for six papers presented. Thirteen additional papers discuss additional aspects of global chemical cycles.

10910 **Introduction.** Stumm, W. (Swiss Federal Inst. of Tech., Zurich). pp 13-21 of In Global chemical cycles and their alterations by man. Stumm, W. (ed.). Berlin; Abakon Verlagsgesellschaft (1977).

From Workshop on global chemical cycles and their alterations by man; Berlin, F.R. Germany (15 Nov 1976).

See CONF-761184—.

We can trace, for each of the most important chemical elements concerned, the broad outline of its cycle in nature. The elements and simple compound principally concerned are carbon (CO_2), oxygen (O_2), nitrogen (N_2, NH_3, NO_2^-, NO_3^-), water (H_2O), and phosphorus (PO_4^{3-}). Brief consideration is given to each of these cycles in turn.

10911 **Biological response to fossil fuel combustion products.** Delwiche, C.C.; Likens, G.E. (Univ. of California, Davis). pp 73-88 of In Global chemical cycles and their alterations by man. Stumm, W. (ed.). Berlin; Abakon Verlagsgesellschaft (1977).

From Workshop on global chemical cycles and their alterations by man; Berlin, F.R. Germany (15 Nov 1976).

See CONF-761184—.

The combustion of fossil fuels can influence biological processes both by the injection into the atmosphere of foreign substances not otherwise found in the atmosphere and by altering the concentrations of other atmospheric constituents. Present rates of fossil fuel use are sufficient to have altered considerably the cycles of carbon, nitrogen, sulfur, and phosphorus.

10912 **Fossil fuel burning: its effects on the biosphere and biogeochemical cycles. Group report.** Lerman, A.; Bernhard, M.; Bolin, B.; Delwiche, C.C.; Ehhalt, D.H.; Gessel, S.P.; Kester, D.R.; Krumbein, W.E.; Likens, G.E.; Mackenzie, F.T.; Reiners, W.A.; Stumm, W.; Woodwell, G.M.; Zinke, P.J. pp 275-289 of In Global chemical cycles and their alterations by man. Stumm, W. (ed.). Berlin; Abakon Verlagsgesellschaft (1977).

From Workshop on global chemical cycles and their alterations by man; Berlin, F.R. Germany (15 Nov 1976).

See CONF-761184—.

The burning of fossil fuels (peat, coal, petroleum) and wood produces a variety of gaseous oxides of carbon, nitrogen, hydrogen, and sulfur, compounds of heavy metals, and solid particles (ash). Their redistribution among the hydrosphere, lithosphere, and biosphere is to a large extent mediated by their residence times in the atmosphere, long or short as the case may be. Addition of carbon dioxide and other gases to the atmosphere may affect the climate of the earth. Climatic changes of such an origin would potentially affect the life on earth in the broadest sense, from changes in the structure of ecological systems to the mental state of the earth's human inhabitants. The relationships between biological productivity and fuel burning are discussed.

10913 **Source functions: fossil fuel combustion products, radionuclides, trace metals, and heat. Group report.** Morgan, J.J.; Bach, W.; Eriksson, E. pp 291-311 of In Global chemical cycles and their alterations by man. Stumm, W. (ed.). Berlin; Abakon Verlagsgesellschaft (1977).

From Workshop on global chemical cycles and their alterations by man; Berlin, F.R. Germany (15 Nov 1976).

See CONF-761184—.

Global chemical cycles involve a variety of sources, sinks, reservoirs, and fluxes of the chemical elements and their compounds. For global cycles, in principle, all natural and man-influenced sources and sinks for chemical substances and energy are of potential significance. Interactions of chemical and energy source functions in affecting global environment may be strong. Source functions of special interest are those which characterize man's alteration of global cycles, for example fluxes of carbon dioxide, radionuclides, fixed nitrogen, heat, toxic substances such as trace metals, and synthetic organics. Topics discussed include some aspects of the CO_2 problem, including CO_2 source functions and future CO_2 burdens in

the atmosphere; climatic consequences; possible errors in measuring fossil fuel consumption; radionuclides from the nuclear fuel cycle (release, global distributions, and population exposure); global mobilization of metals; the solar constant; the albedo; and halocarbons.

10914 Belgian network for the determination of heavy metals. Kretzschmar, J.G.; Delespaul, I.; DeRijck, T.; Verduyn, G. (SCK/CEN, Mol, Belgium). *Atmos. Environ.;* **11**: No. 3, 263-271(1977).

During the period May 1972 to April 1975 the daily average levels of Pb, Zn, Cd, Ba, V, Ni, Mn, Cu, Cr, and Fe were routinely determined at fifteen different stations by means of emission spectrography on dust collected on Whatman 41 cellulose filters in a specially designed high volume sampler. The main characteristics of sampling and analysis procedures are described and the most important statistical results for the elements under investigation are summarized. Comparison with similar results obtained by other investigators confirms the average range of the pollution in the country. Future trends in this five year program are specified.

10915 Sensing sulfur oxides and other sulfur bearing pollutants with solid electrolyte pellets. I. Gas concentration cells. Chamberland, A.M.; Gauthier, J.M. (Hydro-Quebec Inst. of Research, Varennes, Can.). *Atmos. Environ.;* **11**: No. 3, 257-261(1977).

A new sensing technique using a solid electrolyte has been demonstrated for sulfur-bearing pollutants. Based on potentiometric measurements across a pellet of potassium sulfate, this sensor allows concentrations of sulfur dioxides, sulfur trioxide, hydrogen sulfide, methyl mercaptan and carbonyl sulfide in air to be measured with accuracy. Its operational concentration range at the present time is 0.1 ppM up to at least 10,000 ppM. The presence of other common pollutants such as carbon dioxide, methane, nitric oxide and nitrogen dioxide does not interfere with the measurement of air samples containing sulfur-bearing pollutants.

10916 Oxidation of SO_2 to sulfates in dispersing plumes. Lusis, M.A. (Atmospheric Environment Service, Downsview, Ont.); Phillips, C.R. *Atmos. Environ.;* **11**: No. 3, 239-241(1977).

A mathematical model is derived for the oxidation of SO_2 to sulfates in chimney plumes. The model assumes slow conversion rates, and uses Freiberg's (1974, 1976) kinetic mechanism for the oxidation of SO_2 in aqueous aerosols in the presence of iron catalyst. The predictions are discussed in the light of some measurements made in the plume of a nickel smelter (Lusis and Wiebe, 1976).

10917 Smog chamber study of the potential effects of hydrocarbon reductions on nighttime NO_2 concentrations. Kamens, R.M.; Jeffries, H.E.; Fox, D.L.; Alexander, L. (Univ. of North Carolina, Chapel Hill). *Atmos. Environ.;* **11**: No. 3, 225-229(1977).

Chemical data from outdoor smog chamber experiments (22-h duration) using a simulated hydrocarbon mix and NO/sub x/ are presented. These data show that reductions in hydrocarbons of 50 to 85 percent from an initial average concentration of 2.9 ppMC (same initial NO/sub x/) frequently result in high nighttime NO_2. The high nighttime NO_2 was associated with low afternoon oxidant. The reverse was also true; low nighttime NO_2 was related to high afternoon oxidant. The dark reaction between O_3 and NO_2 seemed primarily responsible for nighttime removal of NO_2. This was supported by photochemical modeling. The contribution of nighttime NO_2 to the total 22-h NO_2 dosage was about 30 percent in higher hydrocarbon concentration experiments, and about 60 percent in lower hydrocarbon concentration experiments. From these experiments it is apparent that low initial hydrocarbons, poor solar radiation, or a combination of both could result in high nighttime NO_2.

10918 Analytical model for air pollutant transport and deposition from a point source. Ermak, D.L. (Univ. of California, Livermore). *Atmos. Environ.;* **11**: No. 3, 231-237(1977).

An atmospheric transport and deposition model is presented for pollutants emitted from an elevated point source over flat terrain. The model is obtained from the analytic solution of the atmospheric diffusion equation with the coefficients of eddy diffusion taken to be functions of downwind distance and the average wind velocity taken to be constant. Ground deposition of the pollutants is accounted for by (1) including a gravitational settling term in the atmospheric diffusion equation and by (2) applying an absorptive boundary condition at the ground surface. In order to facilitate application of the model, the results for the general situation that includes settling and deposition (and where the distribution is no longer Gaussian) are expressed in terms of the Gaussian plume parameters, and specifically the crosswind and vertical standard deviation functions sigma/sub y/(x) and sigma/sub z/(x). Graphs of the pollutant air concentration and ground deposition flux are presented for a number of deposition conditions.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 9776, 9777, 9834, 10242, 10409, 10906, 10909, 10913, 11023

10919 (BNL—23112) **Monitoring of radioiodine from containment accidents.** Distenfeld, C.H.; Klemish, J.R. (Brookhaven National Lab., Upton, N.Y. (USA)). Jul 1977. Contract EY-76-C-02-0016. 20p. (CONF-770720—5). Dep. NTIS, PC A02/MF A01.

From 22. annual meeting of the Health Physics Society; Atlanta, Georgia, USA (3 Jul 1977).

An air sampling system was developed that merged the useful properties of solid adsorbers, vacuum cleaner air movers, and Civil Defense GM survey meters. The system can be used to monitor the environmental levels of ^{131}I produced by release from containment accidents in nuclear power reactors.

10920 (DP—1455) **Savannah River Laboratory environmental transport and effects research. Annual report, 1976.** Crawford, T.V. (comp.). (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). May 1977. Contract EY-76-C-09-0001. 256p. Dep. NTIS, PC A12/MF A01.

Separate abstracts were prepared for the individual sections of the report.

10921 (DP—1455, pp 13-17) **Source—term study of plutonium-bearing particles from a nuclear fuel reprocessing plant.** Sanders, S.M. May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Fuel reprocessing facilities at the Savannah River Plant (SRP) occasionally release small quantities of ^{239}Pu in particulate form. The total accumulated release of such particles has never exceeded 1 mCi/yr. A program to determine the origin and subsequent environmental behavior of this long-lived radionuclide was undertaken. As part of this study, airborne particles bearing plutonium were isolated from two exhaust systems in the plutonium finishing operation (JB-Line) in Building 221-F and their elemental compositions were determined.

10922 (DP—1455, pp 27-30) **Pollen as a monitoring tool.** Kirkham, M.B. (Univ. of Massachusetts, Amherst); MacMurdo, K.W.; Corey, J.C. May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Pollen was collected and analyzed at the Savannah River Plant (SRP) to determine possible concentration of environmental trace metals by honeybees. The pollen was analyzed with neutron activation, spark source mass spectrometry, and gamma spectroscopy techniques. Pollen was found to be a sensitive indicator of radioactive contaminants, particularly cesium. The data also indicate higher concentrations of trace elements exist downstream of SRP facilities.

10923 (DP—1455, pp 49-52) **Aerial radiological survey of the Savannah River marine region.** Hayes, D.W. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

In December 1975, an airborne radiological survey of the Savannah River marine region was made to establish the present terrestrial exposure rate of this area and to determine if background radiation anomalies were present. Analyses of the survey data revealed over 80 percent of the area has an exposure rate of less than 4 μR/hr, and a small accumulation of ^{137}Cs has occurred in only one area, the dredge spoils on Hutchinson Island.

10924 (DP—1455, pp 175-176) **Evaluation of the wind rose meteorological model using ^{85}Kr receptor data.** Pendergast, M.M. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

The assessment of long-term environmental effects of industrial pollution is frequently obtained with a so-called stability wind rose model in combination with the Gaussian plume equation. Concentrations obtained with this model should be correct to within a factor of 2 or 3 when meteorological conditions at the point of release are identical with those conditions at the valid point of the calculation, normally within 1 km. As the distance between these two points increases, the validity of the wind rose model degrades. The wind rose model is reasonably successful for predicting long-term average concentrations out to distances of 10 km from the source. As increased emphasis is placed on regional transport of air pollution, the wind rose model is being applied (without verification) over distances in excess of 50 km. This report presents some preliminary tests for long-range application of the wind rose model by measuring ^{85}Kr concentrations at 13 sites. These sites were located

31 to 143 km from a point source at the Savannah River Plant (SRP). Comparisons are presented of annual averaged concentrations. The calculations use meteorological data from the WJBF-TV near Beech Island, South Carolina, located 16 km from the ^{85}Kr-emitting source.

10925 (DP—1455, pp 183-186) **Comparison of curved trajectory atmospheric transport vs. assumed straight-line transport.** Cooper, R.E. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

The Dose-To-Man program as currently being implemented at the Savannah River Laboratory provides estimates of the environmental effects of Savannah River Plant operations. These estimates utilize a polar grid structure and assume straight-line transport of materials released to the atmosphere to distances beyond grid boundaries. The assumption of straight-line transport is standard for such estimates and greatly simplifies the computations involved in providing estimates of effects. Generally, the atmospheric transport trajectory will be curved; and, for distances out to 100 km or so, the assumption may lead to significant error. Therefore, a computer code was constructed to provide an estimate of the curved trajectory transport relative to straight-line transport over an extended time period.

10926 (DP—1455, pp 193-198) **Measuring ^{85}Kr concentrations around a nuclear fuel reprocessing facility.** Craft, R.C.; McMillan, W.G. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

In the spring of 1974, Savannah River Laboratory (SRL) personnel began a cooperative research project to improve calculations of the transport and dispersion of materials released to the atmosphere. ^{85}Kr, a noble gas, is ideal for tracing the path of released materials because (a) it does not react chemically with other substances in the air or on the ground, and (b) it is radioactive and very small quantitites can be measured with special instruments. This report documents a small portion of the overall project: the collection of the samples, and an estimation of the individual exposure rates at the sample locations. Approximations of the dispersal of the ^{85}Kr are given in two diagrams. The exposure rates indicate that no significant individual doses are probable. Samples will continue to be collected through September of 1977.

10927 (DP—1455, pp 199-201) **Tritiated methane released from tritium production facilities.** Milham, R.C. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

A sampler has been in use at the Savannah River Plant (SRP) for the past four years to determine the chemical forms and quantity of tritium released to the atmosphere. In the tritium processing facility at SRP, some tritium is released that is neither elemental or oxide. This tritium was identified in an organic gas, probably methane. Although only released in small quantities, steps have been taken to reduce its release. In future work, the ratio of tritium to hydrogen in the methane will be determined.

10928 (DP—1455, pp 203-208) **Description of the ARAC multi-laboratory tests of December 1975.** Kern, C.D. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

In December 1975, multi-laboratory aircraft-supported tests extended the tests performed in June 1974 (see Reference 1 for details of the 1974 tests). The earlier tests were to demonstrate concepts of the Atmospheric Release Advisory Capability (ARAC) developed by the Lawrence Livermore Laboratoty (LLL). These December 1975 tests were to demonstrate further the feasibility of the LLL-ARAC concepts tc predict location, time, and concentration of releases to the atmosphere. Since the aircraft had been funded for a specific period of time, a number of other missions were also performed, some in collaboration with other ERDA-supported laboratories.

10929 (DP—1455, pp 209-214) **Preliminary results from sulfur hexafluoride and deuterated methane releases of December 10, 1975.** Kern, C.D. (Savannah River Lab., Aiken, SC); Ferber, G.; Guthals, P.; Barr, S.; Deitz, R. May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Multi-laboratory experiments were performed at the Savannah River Plant (SRP) during December 1975. Of all the experiments, the one involving the sulfur hexafluoride and deuterated methane on December 10 was the most extensive. This experiment tested the LLL-ARAC system and the relative effectiveness of several different tracers for atmospheric transport and diffusion studies. The goals of this test were: to determine whether sulfur hexafluoride, krypton-85, and deuterated methane tracers [methane-20 ($^{12}C^2H_4$) and methane-21 ($^{13}C^2H_4$)] give comparable results when they are released and sampled simultaneously; to study the transport and dispersion of the plume out to 100 km from the point source; to gain experience in release, sample processing, and analyzing these tracers; and to exercise the LLL-ARAC system. The comparisons of the relative effectiveness of the deuterated methane and sulfur hexafluoride as tracers indicated that the methane concentrations were a factor of 4 below the sulfur hexafluoride concentrations when normalized to consistent units. The ^{85}Kr results differed from the other two tracers as a result of a difference time sequence of release.

10930 **Maximum permissible concentration (MPC) values for spontaneously fissioning radionuclides.** Ford, M.R.; Snyder, W.S.; Dillman, L.T.; Watson, S.B. (Oak Ridge National Lab., Tenn. (USA)). *Health Phys.;* **33**: No. 1, 35-43(Jul 1977).

Maximum permissible concentration (MCP) values in air and water for spontaneously fissioning radionuclides in use at present are given in Title 10, Code of Federal Regulations, Part 20. In the work reported here these MPC values have been computed using (1) more recent decay data, (2) revised metabolic models, and (3) dosimetry techniques developed during the intervening years. The method of Dillman and Jones (Health Phys.; 29:111 (1975)) is used to obtain the energy released in spontaneous fission and to compute the subsequent dose to body organs from the various radiations. The deposition and retention patterns in the respiratory tract and other body organs are taken principally from ICRP Publication 19, and the gastrointestinal model is from Eve (Health Phys.; 12:131 (1966)). The new values are generally within a factor of 2 or 3 of the limits now in use, although in a few cases factors of 5 to 20 are found.

10931 **Radioactive inputs into the environment; comparison of natural and man-made inventories.** Haury, G.; Schikarski, W. (Kernforschungszentrum, Karlsruhe, Ger.). pp 165-188 of In Global chemical cycles and their alterations by man. Stumm, W. (ed.). Berlin; Abakon Verlagsgesellschaft (1977).

From Workshop on global chemical cycles and their alterations by man; Berlin, F.R. Germany (15 Nov 1976).

See CONF-761184—.

Concentrations and global inventories of radioactive materials and their natural cycles are compared with artificial radioactivity production by the nuclear energy industry. Future projections are discussed for some special radionuclides of natural as well as artificial origin and for some others which are of particular interest with respect to environmental impact.

10932 **Environmental task before us.** Liverman, J.L. (Energy Research and Development Administration, Washington, D.C. (USA)). pp 1-5 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From Symposium on transuranium nuclides in the environment; San Francisco, Calif., USA (17 - 21 Nov 1975).

In this introductory address to the symposium, the speaker emphasizes the need to find viable technological answers to the questions being posed about the risk to the environment and hence on human health, of the expanded use of nuclear power for the generation of much needed energy in the short range before other energy sources are brought in line in the long range.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

10933 (DP—1455, pp 167-169) **Power law profiles of mean winds and horizontal and vertical standard deviations of wind direction at Savannah River Plant.** Pendergast, M.M. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Downwind air concentrations from atmospheric pollutant releases are calculated with data from pollutant emissions and from a calculation of plume spread. Most calculational models use one of a number of empirically derived relationships which express plume spread as a function of downwind distance and atmospheric turbulence. The best plume spread relationships are based on direct measurements of atmospheric turbulence, i.e., the standard deviations of horizontal and vertical wind direction (sigma/sub theta/ and sigma/sub phi/) and wind speed (u) at the height of the release. Often measurements of u, sigma/sub theta/, and sigma/sub phi/ are not available at all heights of interest, and values must be interpolated from available data. This report presents results of an analysis of the applicability of the power law profile between 10 and 304 m at the WJBF-TV tower near the Savannah River Plant.

10934 (DP—1455, pp 171-174) **Turbulence statistics as a function of sampling period.** Pendergast, M.M. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Estimates of horizontal and vertical plume spread (sigma/sub y/ and sigma/sub z/, respectively) from measurements of sigma/sub theta/ and sigma/sub phi/ have other limitations besides that caused by sampling period. The relationships developed for sigma/sub y/ and sigma/sub z/ as a function of sigma/sub theta/ and sigma/sub phi/ represent the ensemble average of a number of experiments. These relationships, therefore, are appropriate to obtain long-term average concentrations from many individual cases. When these relationships are used for a single case, a certain amount of variability is expected. This variability can be estimated by analyzing the variability of the original experimental data (i.e., sigma/sub y/ or sigma/sub z/). The variability of the magnitude of the diffusion coefficients can also be estimated by the variability of sigma/sub theta/ and sigma/sub phi/.

10935 Predicted climatology of cooling tower plumes from energy centers. Hanna, S.R. (Air Resources Atmospheric Turbulence and Diffusion Laboratory, NOAA, Oak Ridge, Tenn. 37830). *J. Appl. Meteorol.;* **16**: No. 9, 880-887(Sep 1977).

A one-dimensional plume and cloud growth model is applied to four months of radiosonde observations from Nashville, using as initial conditions the plume from single large cooling towers with waste heat outputs of 10^3, 10^4 and 10^5 MW, and a complex of cooling towers with a total waste heat output of 10^5 MW. Estimates of average annual plume rise from the four energy sources are 580, 1180, 2460 and 780 m, respectively.The predicted plume rise, visible plume length and cloud formation are given as functions of time of day, year and weather type. For example, a cloud forms at the top of the plume from the 10^3 MW tower in 65% of the morning soundings during which ground level fog was observed. A cloud is predicted to occur 95% of the time at the top of the plume from the single 10^5 MW tower. It is found that if the towers in an energy center are separated by a distance greater than the average plume rise from one tower, then plume merging is minimized. Observations from TVA's Paradise steam plant are used to test the predictions of visible plume length from a single 10^3 MW tower.

SITE RESOURCE AND USE STUDIES

10936 (DP—1455, pp 179-182) **Tornadoes on the Savannah River Plant.** Pepper, D.W. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

The two tornadoes of May 28, 1976, that struck the Savannah River Plant moved in an unusual direction. Nearly all tornadoes that have been observed and recorded in the Southeast have moved in a northeasterly direction. Both tornadoes that struck on May 28, 1976, moved in a northwesterly direction. The tornado that occurred during the period July 2 to 4, 1976, moved from west to east. The tornadoes that struck SRP in 1976 were not of great consequence in themselves. However, they provided an opportunity to record data that may be useful in predicting trajectories and intensities of future storms. Timely warnings well in advance of a storm could alleviate the consequence of a severe tornado strike.

REGULATIONS

REFER ALSO TO CITATION(S) 9649, 10903

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

REFER ALSO TO CITATION(S) 10901, 10902

10937 (EDFB/IBP—77/1) **Forest Island edges: their structure, development, and importance to regional forest ecosystem dynamics.** Ranney, J.W. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 47p. Dep. NTIS, PC A03/MF A01.

Forested tracts surrounded by non-forested land develop characteristic edge habitats. These habitats often differ from interior forests in: tree species composition, primary productivity, structure, development, animal activity, and propagule dispersal capabilities. The differences vary according to edge aspect, the way a forest boundary may be structurally maintained by man, and the composition and age of a forest when an edge is created. Edge habitats may vary from 5 to 20 meters wide and, in the case of small forest islands of about two hectares or less, the entire island may display edge conditions. Side-lighting increases the amount of light an edge receives to the point of increasing primary productivity above normal interior forest rates even though dessication may lessen maximal productivity. These edge conditions have been characterized in the literature by the presence of shade-intolerant, xeric-tolerant tree species normally associated with early stages of forest development. The majority of the forest islands examined have been at near-climax states of development, while the edges of these islands did not exceed a maximum age of 100 years. It is not known if forest edge development reaches an equilibrium similar to states attained by adjoining forest interiors. In some landscapes dwindling interior forest habitats are becoming more widely spaced, while the proportional area of edge is increasing. Edges receive stronger winds than interiors and are often more frequently visited by potential seed-dispersing animals. This suggests that the inter-island seed rain is strongly comprised of seeds from edge plants.

10938 Systems model and simulations of calcium dynamics in a pine litter community. Cornaby, B.W.; Vyas, A.B.; Garten, C.T.; Embry, J.R. (Univ. of Georgia, Athens). *Vidya;* 140-152(1972).

A systems model is developed for the litter subsystem on the forest floor of a white pine plantation. The paper also describes specific steps for simulating the behavior of calcium in the system under selected experimental conditions.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 9595, 9653, 9655, 10021, 10910

10939 (DP—1455, pp 39-41) **Oil biodegradation study at the Savannah River Plant.** Watts, J.R. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Waste lubricants and other organic liquids are a byproduct of most large industrial complexes. They are discarded by two methods: ponding (biodegradation) or burning. Both techniques have environmental impact. Oak Ridge, Tennessee, and Deer Park, Texas, studies found soil biodegradation acceptable for routine oil disposal. At the Savannah River Plant (SRP), the majority of the used oils are burned in an onsite power plant as a supplemental energy source to coal. However, some organic fluids are not acceptable for burning. In July 1975, SRL began investigating soil biodegradation as a method to dispose of nonburnable organic liquids. To be an acceptable method, biodegradation must restore the fertility and appearance of the land to the preapplication level, and must permit no oil migration to the water table or to surface streams during the degradation process.

10940 (DP—1455, pp 43-45) **Effect of stack releases from a coal-fired powerhouse on trace element contents of neighboring soil and vegetation.** Horton, J.H. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

The Savannah River Plant 400-D Area powerhouse has operated since 1952 and consumes about 360,000 kg of coal per year. From startup until late 1975, this powerhouse operated without electrostatic precipitators. The objective of this study is to estimate the quantities of trace elements released before electrostatic precipitators were installed and to determine the influence of these releases upon the trace element content of surrounding soils and vegetation which are typical for much of the Coastal Plains of the Southeastern United States. Results to date indicate that none of twenty-six trace elements which have been measured in fly ash have produced measurable effects on the concentrations in soil or vegetation; however, mercury (not normally associated with fly ash because of its volatility) concentration in surface soil does appear to be influenced by stack releases.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 9776, 9777, 10922, 10932, 11003, 11022

10941 (DP—1455, pp 35-37) **Assessment of potential radiation dose from an acute tritium release into a forest ecosystem.** Watts, J.R.; Murphy, C.E. Jr. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

An accidental release of 479,000 curies of tritium gas occurred at the Savannah River Plant (SRP) on May 2, 1974. Environ-

mental monitoring data confirmed that the release first touched the ground at the plant boundary, approximately 15 km from the release point. Standard meteorological methods calculated that the cloud would pass the contact point in approximately one hour. The monitoring data showed that less than 1 percent of the release was tritiated water (HTO). Some of the HTO was assimilated directly into the forest ecosystem by diffusion and by direct exchange. The patterns of uptake suggest that some molecular tritium was converted to HTO by soil microorganisms and plants. The HTO diffused and/or exchanged between soil and plants, maintaining an elevated air concentration after the initial puff had passed. Tritium was also observed in pine needles for 70 days. A model was developed which simulated the absorption of molecular tritium by forests and the subsequent release of HTO into the atmosphere. The predicted concentrations by the model are in agreement with the values of soil, leaf, and air concentrations of HTO found following the release of May 1974. The model predicts a diurnal cycle of tritiated water vapor with higher concentrations at night when air movement under the canopy is slow.

10942 (LA—6952-PR) **Environmental and radiological safety studies. Progress report, April 1—June 30, 1977. Interaction of $^{238}PuO_2$ heat sources with terrestrial and aquatic environments.** Waterbury, G.R. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36. 30p. Dep. NTIS, PC A03/MF A01.

The containers for $^{238}PuO_2$ heat sources in radioisotope thermoelectric generators are designed with large safety factors to ensure that they will withstand reentry from orbit and impact with the earth and safely contain the nuclear fuel until it is recovered. Existing designs have proved more than adequately safe, but the Office of the Assistant Director for Space Application of the ERDA Division of Nuclear Research and Application continually seeks more information about the heat sources to improve their safety. The work discussed includes studies of the effects on the heat source of terrestrial and aquatic environments to obtain data for design of even safer systems. The data obtained in several ongoing experiments are presented; these data tables will be updated quarterly. Discussions of details of the experimental testing are minimized, and they will be largely repetitive in succeeding reports to emphasize the main purpose, compilation of all usable data generated in each experiment. Included are data from environmental chamber experiments that simulate terrestrial conditions, experiments to measure PuO_2 dissolution rates, soil column experiments to measure sorption of plutonium by soils, and several aquatic experiments.

SOIL

REFER ALSO TO CITATION(S) 9743, 9822, 9823, 9824, 9825, 9826, 9827, 9828, 9829, 9830, 9831, 9832, 9833, 10961

10943 Interaction of plutonium with complexing substances in soils and natural waters. Bondietti, E.A.; Reynolds, S.A.; Shanks, M.H. (Oak Ridge National Lab., Tenn. (USA)). pp 273-287 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

See CONF-751105—.

The reactions of Pu with selected organic substances found in the environment have been studied to evaluate the valence and metalcomplex behavior of Pu. Hexavalent Pu (and by inference pentavalent Pu) was unstable in the presence of fulvic acid, polygalacturonic acid, and alginic acid. Citrate-Pu(VI) complexes, however, were relatively more stable. Plutonium (IV) was the most stable valence upon interaction with these organics. Further reduction of Pu(IV) to Pu(III) occurred by fulvic and humic acids. The reduction, under aerobic conditions, does not appear to occur above pH 3.1. The reduction mechanisms is probably similar to the Fe(III) reduction previously documented for phenolic humic substances. Data are presented that demonstrate that Pu is at least partially associated with humic materials in ORNL soil contaminated 30 years ago with trace levels of Pu. Desorption studies using solid exchange resins also showed that, while a cation exchange resin did not desorb Pu from soil after 14 weeks equilibration, chelating resin effected Pu desorption. The desorption rate was not constant, suggesting differential Pu forms. While the resin-extractable Pu was believed to originate from solid-phase organic complexes, over 80% of the Pu in this soil was not readily resin-desorbable. This indicates that more inert soil-Pu reaction products effectively immobilize soil Pu. Some of these associations also appear to be organic.

10944 Migration of plutonium in natural soils. Jakubick, A.T. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. zur Behandlung Radioaktiver Abfaelle). pp 47-61 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

CONF-751105—.

The paper deals with the deposition and migration of fallout plutonium, which is considered here as analogous to an industrial PuO_2 contamination of soil. By correlating the few $^{239,240}Pu$ measurements available in Germany with the fallout data coming from Ispra the probable history of Pu concentration in the air is reconstructed for S.W. Germany. From these data the Pu input function in the vicinity of Heidelberg is derived. The calculated cumulative deposition seems to agree well with the existing measurements of the total amount of $^{239,240}Pu$ in the soil. To find out the transport mechanism of Pu in soil, the data of Pu distribution in soil provided by HASL have been applied for S.W. Germany. The removal of PuO_2 particles from a given layer seems to obey an exponential law with a characteristic turnover time of 5 to 6 years in a 5cm thick partially saturated soil layer. Using the previously derived input function and the estimated turnover time, the probable Pu concentration in the top soil in Germany was computed. Furthermore, the case of instantaneous soil contamination is considered. It is shown that a model using a sequence of boxes leads to a Poisson-type equation which predicts for PuO_2 a migration velocity of 0.8 cm/a. Finally, the relative migration velocities of PuO_2 and $Pu(NO_3)_4$ are compared, indicating that the migration of PuO_2 is about 100 times faster than that of plutonium when applied to soil in the $Pu(NO_3)_4$ form.

10945 Interaction of $^{238}PuO_2$ heat sources with terrestrial and aquatic environments. Patterson, J.H.; Nelson, G.B.; Matlack, G.M.; Waterbury, G.R. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 63-77 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

See CONF-751105—.

Radioisotope thermoelectric generators used in space missions are designed with a great factor of safety to ensure that they will withstand reentry from orbit and impact with the earth and safely contain the nuclear fuel until it is recovered. Existing designs, utilizing $^{238}PuO_2$ fuel, have proved more than adequately safe. More data about the interaction of this material with terrestrial and aquatic environments is continually being sought to predict the behavior of these heat sources in the extremely unlikely contact of these materials with the land or ocean. Terrestrial environments are simulated with large environmental chambers that permit control of temperature, humidity and rainfall using different kinds of soils. Rain falling on thermally hot chunks of $^{238}PuO_2$ causes the spallation of the surface of the fuel into extremely fine particles, as small as 50nm, that are later transported downward through the soil. Some of the plutonia particles become agglomerated with soil particles. Plutonium transport is more significant during winter than during summer because evaporation losses from the soil are less in winter. Aquatic environments are simulated with large aquaria that provide temperature and aeration control. Earlier fuel designs that employed a plutonia-molybdenum cermet showed plutonium release rates of about $10\mu Ci/m^2s$, referred to the total surface area of the cermet. Present advanced fuels, employing pure plutonium oxide, show release rates of about $20nCi/m^2s$ in seawater and about $150nCi/m^2s$ in fresh water. The temperature of these more advanced heat sources does not seem to affect the release rate in seawater.

10946 Interaction of plutonium with complexing substances in soils and natural waters. Bondietti, E.A.; Reynolds, S.A.; Shanks, M.H. (Oak Ridge National Lab., Tenn. (USA)). pp 273-287 of In Transuranium nuclides in the environment. Vienna; IAEA (1976).

From Symposium on transuranium nuclides in the environment; San Francisco, Calif., USA (17 - 21 Nov 1975).

The reactions of Pu with selected organic substances found in the environment have been studied to evaluate the valence and metalcomplex behaviour of Pu. Hexavalent Pu (and by inference pentavalent Pu) was unstable in the presence of fulvic acid, polygalacturonic acid, and alginic acid. Citrate-Pu(VI) complexes, however, were relatively more stable. Plutonium (IV) was the most stable valence upon interaction with these organics. Further reduction of Pu(IV) to Pu(III) occurred by fulvic and humic acids. The reduction, under aerobic conditions, does not appear to occur above pH 3.1. The reduction mechanisms is probably similar to the Fe(III) reduction previously documented for phenolic humic substances. Data are presented that demonstrate that Pu is at least partially associated with humic materials in ORNL soil contaminated 30 years ago with trace levels of Pu. Desorption studies using solid exchange resins also showed that, while a cation exchange resin did not desorb Pu from soil after 14 weeks equilibration, chelating resin effected Pu desorption. The desorption rate was not constant, suggesting differential Pu forms. While the resin-extractable Pu was believed to originate from solid-phase organic complexes, over 80% of the Pu in

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10947 Interaction of $^{238}PuO_2$ heat sources with terrestrial and aquatic environments. Patterson, J.H.; Nelson, G.B.; Matlack, G.M.; Waterbury, G.R. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 63-77 of In Transuranium nuclides in the environment. Vienna; IAEA (1976).

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10948 Physical and chemical characteristics of plutonium in existing contaminated soils and sediments. Tamura, T. (Oak Ridge National Lab., Tenn. (USA)). pp 213-229 of In Transuranium nuclides in the environment. Vienna; IAEA (1976).

From Symposium on transuranium nuclides in the environment; San Francisco, Calif., USA (17 - 21 Nov 1975).

Plutonium from three sites has been studied to provide information necessary in understanding its behaviour and fate under prevailing conditions. Plutonium in soils from the Nevada Test Site (NTS) was predominantly associated (50 to 75%) with the coarse sit (53 to 20 μm) fraction. The coarse silt fraction was further segregated by density gradient zonal centrifugation; the plutonium in the sample from a bare soil ranged from 60 to 85% in the 'heavy' mineral fraction (>2.9 g/cm^3) suggesting the presence of oxide forms. The plutonium in a sandy mound taken beneath shrubbery occurred predominantly (80 to 95%) in a lighter fraction (2.5 to 2.7 g/cm^3) associated with felspar. Soil extraction of NTS plutonium with 0.1M citric acid solution showed very low solubility (approximately 1%). The plutonium in samples from Oak Ridge National Laboratory (ORNL) and Mound Laboratory (ML) was predominantly in the clay size (< 2 μm). The solubility in citric acid was about 20 to 25% in the ORNL sample and 40 to 50% in the ML sample. Density gradient segregation of the clay size fraction of the ML sample showed the activity distribution to be directly related to the weight of the recovered fraction with enhanced contribution by the very light organic fraction. Approximately 71% was found in the 2.3 to 2.4 g/cm^3 fraction, which contained 65 wt% of the clay and 16% in the < 1.8 g/cm^3 fraction (organic fraction), which contained 6% of the weight fraction. The results obtained are discussed as they relate to the resuspension and plant uptake of plutonium. Citrate solubility of plutonium appears to be promising as a potential 'soil test' solution to predict uptake of plutonium by vegetation.

10949 Plutonium, americium and uranium concentrations in Nevada Test Site soil profiles. Essington, E.H.; Fowler, E.B. (Los Alamos Scientific Lab., N.Mex. (USA)); Gilbert, R.O.; Eberhardt, L.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). pp 157-172 of In Transuranium nuclides in the environment. Proceedings of the symposium organized by the USERDA and the IAEA and held in San Francisco, 17-21 November 1975. Vienna; IAEA (1976).

From Symposium on transuranium nuclides in the environment; San Francisco, Calif., USA (17 - 21 Nov 1975).

Many soil profile samples were collected by the Nevada Applied Ecology Group from five nuclear safety test sites on the Nevada Test Site and Tonopah Test Range in Nevada, USA. The profile samples were analysed for plutonium, americium, and in some cases uranium in order to estimate the depth of radionuclide penetration and level of contamination at specific sampling depths after an extended period of time since deposition on the surface. Nearly 70 individual profiles were examined. About one-half of the profiles exhibited a smooth leaching pattern with more than 95% of the plutonium in the top 5 cm. Other profile patterns are discussed relative to (1) mechanical disturbance of the profile after the initial deposition; (2) accumulation of plutonium in specific zones within the soil profile; and (3) occurrence of large amounts of plutonium in the deepest parts of the soil profile. The implications of these observations are discussed with respect to redistribution of radioactivity by wind, water, and burrowing animal, ingestion by burrowing and grazing animals, uptake by vegetation, and cleanup operations.

10950 Accumulation and transport of soil plutonium in liquid waste discharge areas at Los Alamos. Hakonson, T.E.; Nyhan, J.W.; Purtymun, W.D. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 175-189 of In Transuranium nuclides in the environment. Vienna; IAEA (1976).

From Symposium on transuranium nuclides in the environment; San Francisco, Calif., USA (17 - 21 Nov 1975).

Plutonium inventory estimates for the surface 12.5 cm of soil in Mortandad Canyon did not reflect all the plutonium added to the canyon during a 7 month interval. The methods used in this study indicated that about 2 mCi^{238}Pu and 0 mCisup(239,240)Pu were added to the canyon during the interval, compared with known additions of 5.5 mCi^{238}Pu and 0.4 mCisup(239,240)Pu. The discrepancy likely was the result of the large sampling variability, indicating that inventory changes in this order (i.e. up to 17%) are not detectable with any certainty. However, factors other than sampling variability may be involved, including losses of plutonium to depths exceeding 12.5 cm. The relative distribution of plutonium within the canyon demonstrates that transport has occurred beyond the extent of surface water and that runoff from summer rainstorms can serve as a radionuclide transport vector in landscapes exhibiting these hydrologic features. There was a highly significant relationship between suspended sediment concentrations and total amounts of radioactivity in water. The flow rates achieved during the runoff event play an important part in determining the total amount of sediment and thus radioactivity transported downstream. The storm runoff event sampled during this study resulted in the downstream transport of about 1 to 2% of the sediment inventories of plutonium.

10951 Mass isotopic composition of global fall out plutonium in soil. Krey, P.W.; Hardy, E.P. (Energy Research and Development Administration, New York (USA). Health and Safety Lab.); Pachucki, C.; Rourke, F.; Coluzza, J. (Knolls Atomic Power Lab., Schenectady, N.Y. (USA); General Electric Co., Schenectady, N.Y. (USA)); Benson, W.K. (Energy Research and Development Administration, Washington, D.C. (USA)). pp 671-677 of In Transuranium nuclides in the environment. Vienna; IAEA (1976).

From Symposium on transuranium nuclides in the environment; San Francisco, Calif., USA (17 - 21 Nov 1975).

The mass isotopic content of fall out plutonium in soil samples collected from around the world in 1970 and 1971 showed some variability which correlated with the location of nuclear weapons test sites. Omitting local effects, the global mean ratios of $^{240}Pu/^{239}Pu$, $^{241}Pu/^{239}Pu$ and $^{242}Pu/^{239}Pu$ are 0.176+-0.014, 0.0086+-0.0017 and 0.0044+-0.0011, respectively, corrected to January 1971. Such isotopic data provide the most sensitive technique to resolve mixtures of fall out plutonium with plutonium from a second source. From these data, the ^{241}Am/sup(239,240)Pu activity ratio of integrated fall out on the earth's surface can be estimated and will peak at 0.42 in the year 2037.

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 10242, 10409, 10961

10952 ^{239}Pu contamination in snakes inhabiting the Rocky Flats plant site. Geiger, R.A. (Savannah River Ecology Lab., Aiken, S.C. (USA)); Winsor, T.F. *Health Phys.;* **33**: No. 2, 145-147(Aug 1977).

Results of a study of ^{239}Pu contamination of the tissues of snakes captured in the Rocky Flats Plant site area are presented. It is shown that snakes show some of the lowest ^{239}Pu tissue concentrations of any Rock Flatts biota analyzed, detectable concentrations being found primarily in liver and bone tissues but none in the majority of lung samples. Possible explanations are discussed.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 9653, 10551, 10557, 10558, 10566, 10567, 10573, 10611, 10613

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 10901, 10902, 10990, 11376

10953 (DP—1455, pp 105-108) **Characterization of attached algal assemblages growing on various substrates in artificial streams.** Wilde, E.W. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Studies are currently being conducted at the Flowing Streams Laboratory to gain a better understanding of the components of the attached community which colonize each of the major types of natural substrates. Preliminary results indicate that some taxa are very substrate-specific, while others develop abundant populations on several types of substrates. Glass slides (artificial substrates) appeared to best represent the algae attached to objects in the stream such as rocks, plants, and sticks. True benthic forms were poorly represented on the slides.

10954 (DP—1455, pp 109-112) **Comparison of glass and acrylic substrates in periphyton studies.** Wilde, E.W. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Most quantitative studies of periphytic algae have involved artificial substrates because natural substrates are very difficult to sample in a quantitative manner. Glass or acrylic slides have been used extensively as substrates in diatometers. The primary objectives of this experiment were to compare algal community development on glass and acrylic substrates, and to assess the variability between replicate slides and between diatometers. Significantly higher quantities of algae were collected from acrylic than from glass slides, whereas both substrates gave similar variation between replicates and displayed significant differences between diatometers.

10955 (DP—1455, pp 113-116) **Comparisons of thermal effects on periphyton productivity in a stream vs. a lake ecosystem.** Tilly, L.J. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

The growth of attached algae in thermally altered experimental streams was compared with that in a man-made reservoir receiving thermal effluents from a nuclear reactor. The studies were made to determine whether the potential effects of thermal effluents were generally greater for streams or for lakes that presently receive thermal discharges from industrial power plants. In the present work, ^{14}C uptake by periphyton from Par Pond and from artificial streams in the Flowing Streams Laboratory (FSL) were simultaneously measured from May through November 1976. The data confirmed the earlier findings of temperature-enhanced algal growth in the lake for similar time periods. However, algal growth in the FSL heated streams was not significantly different from that in the unheated streams. These studies are being continued to determine whether nutrient differences limit the response of stream algae to elevated temperature, and whether this pattern is altered under winter conditions.

10956 (DP—1455, pp 157-158) **Examination of SRP effluents for bacterial viruses specific for Aeromonas hydrophila.** Fliermans, C.B. (Savannah River Lab., Aiken, SC); Kasweck, K.L. May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Since high population densities of Aeromonas hydrophila, a fish pathogen, occur in Par Pond and may represent a threat to the fish population, a means of biological control for the bacterium was sought. The purpose of this research was to survey Savannah River Plant (SRP) waters known to contain A. hydrophila for a virus that would specifically infect and kill A. hydrophila. Such viruses are called phage and may be useful as specific biological controls for a given bacterium. Over 65 water sources from SRP were sampled for specific phage without successfully isolating such a virus.

10957 (DP—1455, pp 159-160) **Genetic variability of E. coli in Par Pond.** Fliermans, C.B. (Savannah River Lab., Aiken, SC); Kasweck, K.L. May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Optimum growth temperature for many human pathogen bacteria is near body temperature, 37°C. Some pathogenic bacteria are able to survive for extended periods of time in habitats with nonoptimal temperatures, provided nutrients are available for growth. Previous survival studies of E. coli in Par Pond indicated that these bacteria became variable in a key diagnostic characteristic (lactose utilization) during the study period. This study confirms previous findings of long-term viability and, in addition, demonstrates the genetic variability of this bacterial population in Par Pond. Because identification of fecal coliforms is based primarily on lactose utilization in a selective medium, the variability of this key diagnostic character could lead to serious errors in estimating fecal contamination.

10958 (DP—1455, pp 161-163) **Enumeration and identification of bacterial populations of surface microlayers in Par Pond.** Fliermans, C.B. (Savannah River Lab., Aiken, SC); Kasweck, K.L. May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Large elongated areas of quiet water of slicks are frequent on Par Pond and other southeastern reservoirs. Slick waters may contain greater amounts of organic nutrients than the surrounding waters. Previous studies indicate that higher levels of coliform bacteria and fungi occurred at the surface of the slicks than in the remainder of the water column. The purpose of this research was to determine the distribution of bacterial populations, particularly Aeromonas hydrophila, in surface slicks on Par Pond. Aeromonas hydrophila, a fish pathogen causing red sore disease, occurs in high numbers in Par Pond. The data indicate that the concentration of A. hydrophila as well as the total bacterial population is greater in the microlayer of the slicks than those microlayers out of the slicks.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 9595, 9655, 10910

10959 (DP—1455, pp 231-233) **Emergency response capabilities for aqueous releases.** Kiser, D.L.; Hayes, D.W.; Buckner, M.R. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Computer models of stream and river systems were developed to predict the possible consequences of releases of short duration to major creeks on the Savannah River Plant (SRP) and to the Savannah River. The models predict concentration-time profiles at selected downstream locations. Model and computer parameters are retained in the computer to enable emergency response to releases at selected locations.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 9776, 9777, 10922, 10931, 10932, 10942

10960 (DP—1455, pp 93-96) **Tritium in the Savannah River estuary and adjacent marine waters.** Hayes, D.W. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

The tritium distribution in the Savannah River estuary and adjacent marine waters was measured to provide information on the dilution, mixing, and movement of Savannah River water in this region. The Savannah River marine region was chosen for this study because the average tritium concentration in the Savannah River is 5 pCi/ml, whereas other rivers in the southeastern United States average less than 0.5 pCi/ml. Tritium measurements proved particularly effective in estimating the flushing time of the Savannah River estuary (2.4 days) and in delineating the relative river and sea water contributions to Ossabaw and Port Royal Sounds.

10961 (NVO—269-32) **Radiological survey of plants, animals, and soil at Christmas Island and seven atolls in the Marshall Islands. Progress report for 1974—1975.** Nelson, V.A. (Washington Univ., Seattle (USA). Lab. of Radiation Ecology). Jan 1977. Contract EY-76-S-08-0269. 78p. Dep. NTIS, PC A05/MF A01.

The Division of Operational Safety or DOS (now Safety Standards and Compliance) portion of the Laboratory of Radiation Ecology (LRE) Pacific Radiocology Program (formerly Johnston Atoll Program) began on 1 July 1974 and is continuing. The purpose of this program is to determine the kinds and amounts of radionuclides distributed in the foods, plants, animals, and soil of the Central Pacific, especially the Marshall Islands. Five field trips were conducted for this program between April 1974 and August 1975, and about 600 samples were collected. Results of the analyses indicate that ^{90}Sr and ^{137}Cs are dominant in the terrestrial environment and, in addition, ^{241}Am and /sup 239,240/Pu are also important in the soil from Bikini and Rongelap atolls. Cobalt-60 and ^{55}Fe are predominant in the marine environment together with naturally occurring ^{40}K. Amounts of radioactivity vary between atolls and between

islands within an atoll in relation to the distance from the nuclear weapons test sites. Bikini atoll has the highest amounts of radioactivity, but the northern islands of Rongelap Atoll have only slightly lower amounts. Rongerik and Ailinginae atolls and the southern islands of Rongelap Atoll have similar amounts of radioactivity which are lower than Bikini by factors of 5 to 10 or more. Values at Utirik Atoll are lower still, but are higher than amounts at Wotho and Kwajalein atolls. Christmas Island in the Line Islands has the least amount of radioactivity of the areas surveyed for this report.

10962 Plutonium and americium in Lake Michigan sediments. Edgington, D.N.; Alberts, J.J.; Wahlgren, M.A.; Karttunen, J.O.; Reeve, C.A. (Argonne National Lab., Ill. (USA)). pp 493-514 of In Transuranium nuclides in the environment. Vienna; IAEA (1976).

From Symposium on transuranium nuclides in the environment; San Francisco, Calif., USA (17 - 21 Nov 1975).

The vertical distributions of sup(239,240)Pu, ^{238}Pu and ^{137}Cs have been measured in sediment cores taken from Lake Michigan. Sections from a limited number of cores have been analysed for ^{241}Am. In addition, grab samples from ten locations in the southern basin of the lake have been analysed for phase distribution of sup(239,240)Pu using a sequential extraction technique. The results indicate that the sup(239,240)Pu, ^{238}Pu and ^{137}Cs from weapons testing, and the ^{241}Am formed in situ are concentrated in the sediments. A comparison of the total deposition of sup(239,240)Pu and ^{137}Cs indicates that ^{137}Cs may be valuable as a monitor for sup(239,240)Pu deposition in the sediments. Values of the ^{238}Pu/sup(239,240)Pu ratio are in agreement with values reported in Lake Ontario sediments (and Lake Michigan plankton) and show little variation with depth. ^{241}Am data support the concept of in situ production with little preferential mobility after formation. Studies of sedimentary phase distributions show that sup(239,240)Pu is associated with hydrous oxide phases, which are chemically stable under the prevailing conditions in the lake sediments. Since Lake Michigan sediments remain aerobic, relatively little sup(239,240)Pu is available for chemical mobilization from the hydrous oxide or organic phases present in the sediments.

10963 Colloidal nature of radionuclides in seawater. Feldman, I. (Univ. of Rochester, NY). pp 183-190 of In Environmental toxicity of aquatic radionuclides: models and mechanisms. Miller, M.W.; Stannard, J.N. (eds.). Ann Arbor, MI; Ann Arbor Science Publishers, Inc. (1976).

There is considerable doubt that equilibrium calculations, i.e., employing solubility products and complex-ion stability constants, are valid for the submicro concentrations of radionuclides in seawater. The existence of radiocolloids should be expected in seawater. The great tendency of radiocolloids to adsorb onto finely-divided hydrous oxides makes their formation of significance in seawater, especially for artificial radionuclides. The subject of radiocolloid formation is reviewed in this chapter. It is shown that the ^{226}Ra/^{230}Th/U relationship found in seawater can be explained from the fact that the tendencies of these elements to form radiocolloids in seawater should decrease in order thorium > radium much greater than uranium. This explanation is much simpler than the prevailing oceanographic one. The theories for radiocolloid formation are discussed. The recent theory of Jones and Healy for the adsorption of hydrolyzable metal ions onto hydrous oxides is reviewed briefly, and its relevance to radiocolloid formation is pointed out.

WATER

REFER ALSO TO CITATION(S) 10930, 10947

10964 Plutonium content of Pacific Ocean waters. Miyake, Y. (Geochemistry Research Association, Tokyo, Japan); Sugimura, Y. (Meteorological Research Inst., Tokyo (Japan)). pp 91-104 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

See CONF-751105—.

The content of plutonium in seawater collected during the cruises of 1968 to 1973 in the entire Pacific Ocean, mainly along the line of 170 degree W and 146 degree W longitude extending from 50 degree N to 68 degree S, not only in the surface layer but also in the deep layer down to 3000m depth was determined. Results obtained in the eastern South Pacific and some of the western North Pacific were also reported. The plutonium content in the North Pacific surface water ranged from 2.2 to 9.4X10^{-4}pCi/l, while it is lower in the South Pacific, ranging from 1.3 to 3.4X10^{-4}pCi/l. Intimate correlation was observed between the plutonium content in surface water and ^{90}Sr deposition rate. The ratio of ^{238}Pu/sup(239,240)Pu in surface water ranged from 0.1 to 0.81 in the North Pacific and 0.35 to 2.4 in the South Pacific. These values are in the same order of magnitude as seen in the land fallout during the same period. sup(239,240)Pu/^{137}Cs in surface water ranged from 0.0009 to 0.0028 and it is lower than the average ratio of 0.006 in fallout in Tokyo. In the intermediate or deep layer relatively higher ratios were observed as compared with those in surface water. This suggests a faster downward transport of plutonium in the marine environment than of strontium or caesium.

10965 Distributions of transuranium nuclides in sediment and biota of the North Atlantic Ocean. Bowen, V.T.; Livingston, H.D.; Burke, J.C. (Woods Hole Oceanographic Institution, Mass. (USA)). pp 107-119 of In Transuranium nuclides in the environment. Vienna; IAEA (1976).

From Symposium on transuranium nuclides in the environment; San Francisco, Calif., USA (17 - 21 Nov 1975).

The effects of the interaction of marine sediments with their biotic population on the penetration, redistribution, sediment association and biotic availability of delivered transuranium nuclides are discussed as a function of both sedimentation regimes and in-fauna populations. Data on the penetration and redistribution patterns of fallout transuranium nuclides in the shallow sediments of Buzzards Bay, Massachusetts, are discussed in terms of the known parameters of sedimentation and 'in sediment' biological activity. In this (and most common) type of sedimentation regime, translocation of bioturbationally downmixed transuranium nuclides back toward (and probable loss from) the sediment surface is demonstrated. Various biological and biochemical mechanisms are advanced that may act on these nuclides within sediments. The increased availability to marine biota of sediment transuranium nuclides by these remobilization processes, is indicated by data showing accumulations of these nuclides in marine invertebrates and fish.

10966 Removal of plutonium from drinking water by community water treatment facilities. Corey, J.C.; Boni, A.L. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). pp 401-408 of In Transuranium nuclides in the environment. Vienna; IAEA (1976).

From Symposium on transuranium nuclides in the environment; San Francisco, Calif., USA (17 - 21 Nov 1975).

Plutonium removal factors (RF) averaged 14+-10 during a study of the effectiveness of three drinking-water treatment plants for removing plutonium from Savannah River water. Plutonium concentrations between 0.1 and 3.5 fCi/1 were measured in raw and finished water samples. From 50 to 10000 litre samples of water were concentrated by ion exchange techniques and processed to determine the concentrations of plutonium-239, 240 and to derive plutonium RFs. The similarity between RFs observed for both plutonium and suspended solids suggests a colloidal behaviour for plutonium. Flocculation and filtration appear to be the primary factors in the water treatment process contributing to plutonium removal. The similarity between the plutonium contents of finished water from treatment facilities upstream and downstream of the Savannah River Plant (SRP) indicates that there is no measurable dose-to-man from SRP plutonium releases in the water. The 70-year bone dose commitment to an individual from consumption for one year of 1.65 litres per day of treated Savannah River water, based on the plutonium concentrations of finished waters from the three treatment facilities, is 5X10^{-5}mrem.

10967 Plutonium content of Pacific Ocean waters. Miyake, Y. (Geochemistry Research Association, Tokyo, Japan); Sugimura, Y. (Meteorological Research Inst., Tokyo (Japan)). pp 91-104 of In Transuranium nuclides in the environment. Vienna; IAEA (1976).

From Symposium on transuranium nuclides in the environment; San Francisco, Calif., USA (17 - 21 Nov 1975).

The content of plutonium in seawater collected during the cruises of 1968 to 1973 in the entire Pacific Ocean, mainly along the line of 170 degree W and 146 degree W longitude extending from 50 degree N to 68 degree S, not only in the surface layer but also in the deep layer down to 3000m depth was determined. Results obtained in the eastern South Pacific and some of the western North Pacific were also reported. The plutonium content in the North Pacific surface water ranged from 2.2 to 9.4X10^{-4}pCi/l, while it is lower in the South Pacific, ranging from 1.3 to 3.4X10^{-4}pCi/l. Intimate correlation was observed between the plutonium content in surface water and ^{90}Sr deposition rate. The ratio of ^{238}Pu/sup(239,240)Pu in surface water ranged from 0.1 to 0.81 in the North Pacific and 0.35 to 2.4 in the South Pacific. These values are in the same order of magnitude as seen in the land fallout during the same period. sup(239,240)Pu/^{137}Cs in surface water ranged from 0.0009 to 0.0028 and it is lower than the average ratio of 0.006 in fallout in Tokyo. In the intermediate or deep layer relatively higher ratios were observed as compared with those in surface water. This suggests a faster downward transport of plutonium in the marine environment than of strontium or cesium.

10968 Plutonium radionuclides in the groundwaters at Enewetak Atoll. Noshkin, V.E.; Wong, K.M.; Marsh, K.; Eagle, R.; Holladay, G. (California Univ., Livermore (USA). Lawrence Livermore Lab.); Buddemeier, R.W. (Hawaii Univ., Honolulu (USA)). pp 517-542 of In Transuranium nuclides in the environment. Vienna; IAEA (1976).

From Symposium on transuranium nuclides in the environment; San Francisco, Calif., USA (17 - 21 Nov 1975).

In 1974 a groundwater program was initiated at Enewetak Atoll to study systematically the hydrology and the groundwater geochemistry on selected islands of the Atoll. The program provides chemical and radiochemical data for assessment of water quality on those islands designated for rehabilitation. These and other data are used to interpret the mechanisms by which radionuclides are cycled in the soil-groundwater system. Because of the international concern over long-term buildup, availability, and transport of plutonium in the environment, this program emphasizes analysis of the element. The results of the study show that on all islands sampled, small quantities of plutonium radionuclides have migrated through the soil columns and are redistributed throughout the groundwater reservoirs. The observed maximum surface concentrations are less than 0.02% of the maximum recommended concentration for drinking water. Concentrations of ^{137}Cs are found to correlate with water freshness, but those of sup(239,240)Pu show no such relationship. The mechanisms moving sup(239,240)Pu through the groundwater reservoirs are independent of the processes controlling the cycling of ^{137}Cs and fresh water. A reasonable linear correlation is found between mean surface-water concentrations and soil burdens. The quantities of sup(239,240)Pu migrating to the groundwater surface layers do not correlate with any other known differences in the physical, chemical or biological characteristics of the islands.

AQUATIC ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 10242, 10409, 10965

10969 (DP-MS—77-98) **Plutonium uptake by the green alga Scenedesmus obliquus (Turp) Kutz, as a function of isotope and oxidation state.** Tkacik, M.F. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1977. Contract EY-76-C-09-0001. 45p. Dep. NTIS, PC A03/MF A01.

Thesis. Submitted to Univ. of South Carolina, Columbia.

This study was designed to determine the effect of plutonium chemical valence state on the availability of small concentrations of ^{238}Pu and ^{239}Pu to algae. The uptake experiments involved the green alga Scenedesmus obliquus, grown in batch cultures. Plutonium concentrations accumulated by this alga were linearly related to plutonium concentrations. There was no significant difference (rho = 0.05) in algal plutonium accumulations, on a mass basis, of either ^{238}Pu or ^{239}Pu in either Pu^{+4} or Pu^{+6} oxidation state at the concentrations studied.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

10970 (DP—1455, pp 85-87) **Heat loss in a small cooling pond.** Hayes, D.W. (Savannah River Lab., Aiken, SC); Martinez, R. May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Cooling ponds are designed employing conservative and/or simplified descriptions of heat loss and flow. Heat loss calculations are usually derived from formulae obtained from measuring natural water temperatures on lakes and reservoirs. Extrapolations using these coefficients tend to be conservative at higher temperatures. Therefore, for designing cooling ponds which receive heated waters, such as from a nuclear reactor, data are necessary to confirm the extrapolated values. Additional data are also needed on the importance of density currents on flow regimes within a cooling pond. Density currents are driven by pressure gradients due to density differences. These density differences can be generated by the cooling of water. The resulting currents transport water to unexpected parts of the cooling pond. Realistic examination of heat loss and flow at elevated temperatures under laboratory conditions is difficult; therefore, situations in the environment are needed to illustrate the importance of density currents in heat dissipation. A small cooling pond on the Savannah River Plant (SRP), Pond 2, has the twin features of elevated temperatures (approximately 60°C) and density currents from the cooling of water. The energy loss in Pond 2 was found to be 11 +- 8 MW total or 5.2 MW/hectare (2.1 MW/acre). Surface water temperatures were stable. Bottom water temperatures had a diurnal cycle.

10971 (DP—1455, pp 101-102) **Establishment of a functional thermal stream laboratory facility.** Harvey, R.S. May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

The Flowing Streams Laboratory, on the banks of Upper Three Runs Creek on the Savannah River Plant, has six experimental streams for studying the long-term effects of low-level increases in water temperature on the ecology of aquatic organisms. Although the facility was completed in October 1971, thermal studies did not begin until April 1976 because of the time required for baseline studies and modifications to equipment. Interstream comparisons of water temperature, dissolved oxygen, and pH are placed on magnetic tape by means of data acquisition system, which also compares the light intensity in control streams with that in Upper Three Runs Creek. Other water quality parameters and concentrations of trace elements in Upper Three Runs water are routinely determined from weekly, biweekly, or monthly water samples.

10972 (DP—1455, pp 117-119) **Temperature optima of periphytic communities in thermally altered streams.** Fliermans, C.B. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Stream communities in the Flowing Streams Laboratory at the Savannah River Plant are established in the six model streams. Stationary communities within the four heated streams are subjected to temperature perturbations of 2.5, 5.0, 7.5, and 12.5°C, respectively, above the ambient temperature of the parent stream, Upper Three Runs Creek. The communities have been subjected to these elevated temperatures since April 1976. The maximum temperature attained in the summer was 35.2°C. Subsequently, the minimum winter temperature observed in the ambient temperature streams was 7°C. The present study determined that the response of the periphytic algal and bacterial communities was due primarily to temperature alterations and not to differences in nutrient concentrations. The optimum temperature for algal photosynthesis and bacterial respiration was determined to shift as seasonal and artificial heating temperatures changed. Such observations indicate that these periphytic communities can adapt to low-level thermal stresses. Adaptation is not uniform for all species, however, as species compositions within the communities were found to change with seasons and temperature.

10973 (DP—1455, pp 121-123) **Periphyton composition differences in artificial streams exposed to different temperature regimes.** Wilde, E.W. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Periphytic algae are of considerable ecological significance because they represent the major source of primary productivity in many aquatic ecosystems. Major changes in the abundance and species composition of these algae are usually indicative of, and contributory to, substantial changes in water quality. Studies to determine the impact on periphyton in artificial streams heated 2.5, 5, 6.5, and 12.5°C above ambient temperature are currently being conducted at the Flowing Streams Laboratory of the Savannah River Laboratory (SRL). Preliminary results from qualitative analyses of natural substrate samples indicated that temperature elevations up to 7.5°C caused only minor changes in community structure; whereas, a 12.5°C increase created a dramatic shift in species composition resulting in extreme dominance by filamentous blue-green algae.

10974 (DP—1455, pp 125-130) **Field responses to zooplankton populations to temperature changes caused by reactor operations.** Vigerstad, T.J.; Tilly, L.J. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Field determinations of thermal tolerance limits for zooplankton have helped in the definition of experiments needed to evaluate the effects of reactor operations upon these animals. Currently, the rates of births and deaths for populations of Cladocera are being quantified in hyperthermal and nonhyperthermal areas of the reactor cooling reservoir, Par Pond.

10975 (DP—1455, pp 131-134) **Direct and indirect effects of hyperthermal effluent on aquatic macrophytes in Par Pond.** Grace, J.B. (Clemson Univ., SC); Tilly, L.J. May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Studies on rooted aquatic plants in a reactor cooling reservoir demonstrate that both direct and indirect effects result from the introduction of hyperthermal effluents into such aquatic systems. Direct effects are generally effects mediated through the physiological response of the organisms to conditions of the effluent; indirect effects are influences mediated through interactions such as predation or competition. The 1975 observations of rooting depths of Myriophyllum spicatum and Eleocharis acicularis in relation to the thermal effluent in Par Pond illustrate this point.

10976 (DP—1455, pp 135-139) **Modification of membrane diffusion chambers for deep water studies.** Fliermans, C.B. (Savannah River Lab., Aiken, SC); Gorden, R.W. May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Membrane diffusion chambers as designed and instrumented by McFeters and Stuart have been widely used for the study of

bacterial survival in surface waters of streams or in laboratory situations. However, preliminary experiments in a thermally enriched, deep-water lake (Par Pond) demonstrated the need for modified chambers. The modified chambers, now routinely used in SRL studies, facilitate sampling and resist damage during exposure in the water column.

10977 (DP—1455, pp 145-149) **Aeromonas survival in a thermally altered lake.** Fliermans, C.B. (Savannah River Lab., Aiken, SC); Gorden, R.W.; Hazen, T.C.; Esch, G.W. May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Par Pond, a thermally enriched monomictic southeastern lake, has received considerable research attention due in part to the large populations of fish which are infected with the red sore disease. The chief etiological agent of this disease is apparently the ubiquitous aquatic bacterium Aeromonas hydrophila. Previous studies have considered neither the survival nor the distribution of this bacterium in situ. This paper describes the survival of Aeromonas hydrophila in natural lake waters altered by thermal effluents discharged from a nuclear production reactor. Survival of A. hydrophila under in situ conditions in both epilimnetic and hypolimnetic waters was determined with polycarbonate membrane diffusion chambers during two separate reactor operating conditions. Survival levels of pure cultures of A. hydrophila corresponded to the distribution patterns of the naturally occurring, Aeromonas-like populations. The greater survival of A. hydrophila during full reactor operation suggests that the fish populations may be exposed to high concentrations of this bacterium for relatively long time periods while the reactors are operating.

10978 (DP—1455, pp 151-156) **Seasonal distribution of Aeromonas hydrophila in Par Pond.** Fliermans, C.F.; Hazen, T.C. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Par Pond is a thermally enriched, monomictic, southeastern lake which receives heated effluent from a production nuclear reactor. Fish populations in the lake have lesions from which the bacterium Aeromonas hydrophila is readily isolated. Distribution patterns and seasonal population densities of Aeromonas in the water column were measured. Greater population densities of Aeromonas occurred below the oxygen chemocline when the lake was stratified.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 10573

10979 (DP—1455, pp 77-83) **Modeling of sediment transport in reactor effluent streams.** Kiser, D.L. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Measurements were made of sediment transport on Four Mile Creek (C-Area stream) and Steel Creek (P-Area stream) during draining and/or flushing of cooling water basins in C Area and P Area, respectively. These measurements were used to determine transport coefficients for the Environmental Transport Division (ETD) models for Savannah River Plant (SRP) streams. The models predict sediment transport downstream after discharge of sediments from the basins. Sediment release limitations were established by matching an EPA guideline to predicted concentration-time profiles. The daily maximum releases established are 765 m^3 of mud and 459 m^3 of mud for P Area and C Area, respectively.

REGULATIONS

REFER ALSO TO CITATION(S) 10567, 10569

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 10557, 10561, 10562, 10563, 10565, 10566, 10613, 10910

10980 (BNWL—2107) **Description and comparison of energy impact assessment models.** Burnett, R.A.; Fraley, D.W. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Apr 1977. Contract EY-76-C-06-1830. 96p. Dep. NTIS, PC A05/MF A01.

During the past few years the need for more comprehensive analytical techniques for assessing the environmental, economic, and social impacts of energy supply-demand systems and related public policy-making activities has increased. The research and academic communities have responded to this need by developing a wide range of models and other analytical tools for energy impact estimation. The models generally fall into two categories: large-scale and specialized. This report examines the general features and shortcomings of current large-scale and specialized modeling efforts from the point of view of energy impact assessment. Characteristics deemed desirable in large-scale energy-impact-assessment models and related studies are discussed. An outline of criteria for describing and comparing such models is presented, from which seven large-scale energy models and one impact-assessment study are described and compared in considerable detail. Tables are also presented which summarize the results of the categorizations.

10981 (COO—2314-12) **Progress report on research on human genetics in Iceland, July 31, 1977.** (Iceland Univ., Reykjavik). 1977. Contract EY-76-C-02-3214. 141p. (CONF-770460—6; CONF-770857—1; CONF-770559—2). Dep. NTIS, PC A07/MF A01.

From Spring meeting of the Mining and Metallurgical Institute of Japan; Tokyo, Japan (Apr 1977).

During the period 1974-77 the work has continued according to the plan outlined in previous proposals. A general demographic register, covering the Icelandic population from the year 1840 to present, is being compiled. The register contains some 313,000 birth records, which are kept either on magnetic discs, punched cards, or on written forms. In addition to this are the National Register with birth numbers, marriage records, and death records with causes of death. These registers are used to investigate the possible inheritance of disabilities and diseases as well as other characters and the effect of environment on man.

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 9655, 10565, 10611, 10980

BIOMEDICAL SCIENCES, BASIC STUDIES

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 9558, 10291, 10992, 10996

10982 (ORO—3982-46) **Eukaryotic transcription and processing: regulation of gene expression. Progress report, August 1, 1976—October 31, 1977.** Mans, R.J. (Florida Univ., Gainesville (USA). Dept. of Biochemistry and Molecular Biology). 1977. Contract EY-76-S-05-3982. 5p. Dep. NTIS, PC A02/MF A01.

Progress is reported on the following research programs: catalytic components of an in vitro model system isolated from maize seedlings; initiation of RNA and poly A chains; isolation of ATP; polynucleotide adenyltransferase; and isoelectric focusing of the RNA-primed and DNA-primed exotransferase activities. (HLW)

10983 **Steady state and second time resolved fluorescence of dansyl n-octadecyl amine in bilayer liposomes.** Romero, A.; Sunamoto, J.; Fendler, J.H. (Texas A and M Univ., College Station). pp 111-118 of In Colloid and interface science. Vol. V. Biocolloids, polymers, monolayers, membranes, and general papers. New York; Academic Press, Inc. (1976).

Fluorescence spectra and lifetimes of dansyl n-octadecyl amine (DSOA) have been determined in degassed solutions of methanol, ethanol, chloroform, benzene and n-hexane. Correlations have been obtained between the microscopic solvent polarity parameter E/sub T/(30) and the emission maxima and lifetimes of DSOA in these solvents. Fluorescence spectra and lifetimes of this amine have been also determined in single bilayer liposomes under a variety of experimental conditions. The obtained correlations between the fluorescence parameters of the probes in neat solvents afforded information on the microenvironment of DSOA in the liposomes. Lack of quenching by hexadecylpyridinium chloride indicates that DSOA binds to sites which are well shielded from this quencher.

CYTOLOGY

REFER ALSO TO CITATION(S) 10904, 10999

10984 **Experimental hematology today.** Baum, S.J.; Ledney, G.D. (eds.). New York; Springer-Verlag (1977). 265p. (CONF-760850—).

From Proceedings of the International Society for Experimental Hematology; Washington, District of Columbia, USA (17 Aug 1976).

Separate abstracts were prepared for 26 papers presented at the conference. The abstract of one paper appeared in a previous issue of ERA. (HLW)

10985 **Spermatogenesis in Gardon Rutilus rutilus.** Escaffre, A.M.; Billard, R. *Cah. Lab. Hydrobiol. Montereau;* No. 3, 43-46(Nov 1976). (In French).

The relationship of these results with environmental changes (temperature and photoperiod) is discussed. A descriptive study of spermatogenesis in Gardon Rutilus rutilus showed that the cycle began in September and ended in May. Spermatogonia B were developing between September and March, spermatocytes between January and April, and spermatids in April and May. While spermatozoa were formed in April, the maximum number was attained in May but diminued during June. Radioimmunoassay of the concentration of gonadotropin in the pituitary (equivalent to c-GtH) showed peaks coincident with the phase of multiplication spermatogonia (November), meiosis (February) and spermiation (June).

GENETICS

REFER ALSO TO CITATION(S) 10957

10986 (CONF-770863—1) **Utilization of a quantitative mammalian cell mutation system, CHO/HGPRT, in experimental mutagenesis and genetic toxicology.** Hsie, A.W.; Couch, D.B.; O'Neill, J.P. (Oak Ridge National Lab., Tenn. (USA); Tennessee Univ., Oak Ridge (USA). Graduate School of Biomedical Sciences). 1977. Contract W-7405-ENG-26. 38p. Dep. NTIS, PC A03/MF A01.

From Chemical industry institute of toxicology workshop on strategies for short-term testing for Mutagens/Carcinogens; Research Triangle Park, North Carolina, USA (11 Aug 1977).

Development of the CHO/HGPRT system is described and a host-mediated CHO/HGPRT assay is discussed. The following topics are discussed: evidence for the genetic origin of mutation induction in the CHO/HGPRT system; dose-response relationship for EMS-mediated mutation induction and cell lethality; apparent dosimetry of EMS-induced mutagenesis; structure-activity relationship of alkylating agents and ICR compounds; mutagenicity and cytotoxicity of congeners of two classes of nitrosi compounds; and preliminary validation of the CHO/HGPRT assay in predicting chemical carcinogenicity. (HLW)

METABOLISM

REFER ALSO TO CITATION(S) 10984, 11008, 11017, 11034

10987 (COO—119-252, pp 228-239) **Retention and distribution of ^{241}Am-DTPA, ^{65}Zn-DTPA and Zn—^{14}C-DTPA in rats.** Stevens, W.; Bruenger, F.W.; Atherton, D.R.; Howerton, J.; Buster, D.S. 31 Mar 1977.

In Research in radiobiology. Annual report of work in progress in the internal irradiation program.

The retention and distribution of ^{241}Am-DTPA, ^{65}Zn-DTPA and Zn-^{14}C-DTPA was investigated in male Sprague-Dawley rats. Excretion of the drug was primarily via the urine. The early excretion pattern of DTPA was a function of voiding frequency and time from injection to first micturition. Often more than 50% of the injected material was present in the first urine sample collected. Measurement of the concentration of DTPA in plasma was the most reliable estimate of total body retention, exclusive of the kidney and urinary bladder. For times greater than 1 hr after injection, total body retention of DTPA can be expressed as the sum of two exponentials, an initial fast component and a subsequent slower component.

10988 **Studies on the sizes, shapes, and the development of the lorica of agglutinated Tintinnida.** Gold, K.; Morales, E.A. (New York Zoological Society, Brooklyn). *Biol. Bull.;* **150**: 377-392(Jun 1976).

The Tintinnida of the Woods Hole, Massachusetts region were identified during two consecutive summers; loricae of eleven species of the agglutinated variety were studied by scanning electron microscopy. There were distinct differences in the types of particles utilized. In some species, quartz was incorporated almost to the exclusion of all other minerals. Biogenic particles such as fragments of diatom frustules, protozoan shells, and coccoliths were conspicuous on a number of species. The authors suggest that this observable difference in the nature of the agglutinated particles is significant at the generic level. Variability in the sizes and shapes of the lorica of Tintinnopsis acuminata and T. dadayi are discussed in relation to cell growth and lorica developmental processes.

MEDICINE

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 10876

10989 (LA-UR—77-2409) **Characteristics of computed tomographic reconstruction noise and their effect on detectability.** Hanson, K.M.; Boyd, D.P. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. vp. (CONF-771023—7). Dep. NTIS, PC A02/MF A01.

From Nuclear science symposium; San Francisco, California, USA (19 Oct 1977).

The EMI 5005 scanner produces images with noise characteristics similar to those in simulated CT reconstructions. A detectability phantom is described which will provide a means of investigation of the effect on human detection capability of the peculiar correlations present in the noise present in CT scanner images.

MICROBIOLOGY

REFER ALSO TO CITATION(S) 10956, 10957, 10958, 10977, 10978

10990 (DP—1455, pp 141-144) **Strain specificity of Aeromonas hydrophila: an immunofluorescence study.** Fliermans, C.B. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Par Pond fish, particularly the largemouth bass, and alligator populations are infected with A. hydrophila, which causes red sore disease. The bacterium has been shown to survive for extended periods of time in Par Pond, but does not survive as well in Clark Hill, a nearby large reservoir on the Savannah River. The present study was initiated to characterize the various types of A. hydrophila in Par Pond and in the alligators and bass populations. Strain-specific fluorescent antibodies were prepared for various strains of A. hydrophila isolated from water, largemouth bass, and alligators from Par Pond, a monomictic lake thermally altered by effluents from an SRP production nuclear reactor. Over 200 isolates obtained from water, bass, alligators, and human samples were characterized serologically and biochemically for drug sensitivity and were grouped. A. hydrophila associated with the infections of the largemouth bass and the alligators does not appear to be the serological strain dominant in the water column of Par Pond, nor in the strains examined from the American Type Culture Collection.

PATHOLOGY

REFER ALSO TO CITATION(S) 10956, 10990, 11008

10991 (COO—119-252, pp 240-255) **Incidence of primary lung tumors in beagles.** Taylor, G.N.; Shabestari, L.; Angus, W.; Eaton, J.A. 31 Mar 1977.

In Research in radiobiology. Annual report of work in progress in the internal irradiation program.

The age-specific incidence of 11 primary lung neoplasma, observed in a closed beagle colony, is presented. The first tumor occurred at five years, and the incidence increased progressively in the older age classes. All of the tumors arose from sites distal to the principal bronchi. Although metastases appeared to occur relatively late, they were noted in approximately one-half of the cases and involved the bronchial lymph nodes most frequently.

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 10985

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 11027, 11028

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 10568, 10576

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS ON CELLS

EXTERNAL SOURCE

REFER ALSO TO CITATION(S) 10984, 10995

10992 (COO—2486-366) **Investigations of the biological effects of radiation: a multi-discipline approach. Progress report, September 1, 1976—August 31, 1977.** Friedell, H.L. (Case Western Reserve Univ., Cleveland, Ohio (USA). Dept. of Radiology). 1 Sep 1977. Contract EY-76-S-02-2486. 61p. Dep. NTIS, PC A04/MF A01.

The quasi-free electron attachment rate, k/sub e/, and mobility, μ/sub e/, were studied in non-polar solutions using pulsed conductivity techniques. Measurements of k/sub e/ of >50 nitro compounds in liquids have μ/sub e/ ranging from <0.1 to 100 cm^2/volt sec at temperatures from -100 to +40°C indicated electron-dipole interactions are important in liquids having μ/sub e/ < 1 cm^2/volt sec. The Smoluchowski equation was modified to include electron-dipole interactions and calculated k/sub e/'s agreed with observations within +-20%. The cellular enhancement ratio, CER, of nine of the nitro compounds were measured and a correlation between k/sub e/ and CER was found which was used to refine a model of cellular radiosensitization involving quasi-free electrons. Diffusion-controlled k/sub e/'s were observed for several carcinogens and in reversed micellar solutions. Field-dependent k/sub e/'s were measured in liquids having μ/sub e/ ranging from 10^{-4} to 500 cm^2/volt sec and were found to increase at μ/sub e/ < 1 and decrease at μ/sub e/ > 70 cm^2/volt sec with increasing field. The μ/sub e/ of liquid C_2H_6 was measured from -40°C through the critical temperature at fields up to 180 kV/cm and a transition from polaron to delocalized electron conduction was observed. A picosecond (ps) pulse conductivity technique was developed and hot electron and/or autoionization processes were observed in tetramethylsilane, TMS, 200 ps after the ionizing pulse. A dose, field, and polarity dependent conductivity spike having a lifetime of 100 ps was observed in TMS and is interpreted as a prebreakdown phenomenon.

RADIATION EFFECTS ON MICROORGANISMS

BASIC STUDIES

10993 (TID—27772) **Relation between four types of radiation damage and induced repair.** Radar, M.L. (Pennsylvania State Univ., University Park (USA). Dept. of Biochemistry). Aug 1977. Contract EY-76-S-02-2362. 52p. Dep. NTIS, PC A04/MF A01.

Thesis.

Four strains of Escherichia coli were exposed to uv and gamma radiation. Procedures are described for mutational studies, classification of revertants, inhibition of postirradiation DNA degradation and radioresistance. Comparisons were made of induction of the error-prone repair (epr) system with four mutagens; uv radiation, near uv radiation, gamma radiation, and DNA-protein crosslinks. An increase in the number of mutations was shown in every case. The observation that induction of mutagenesis, induction of inhibition of post-irradiation DNA degradation, and induction of radioresistance are closely parallel phenomena led to the investigation of the possibility that DNA-protein crosslinks which were known mutagens were also inducers of the epr system. The significance of the results is discussed. (HLW)

10994 **Mechanisms in endogenous leukemia virus induction by radiation and chemicals.** Tennant, R.W.; Rascati, R.J.; Lavelle, G.C. (Oak Ridge National Lab., Tenn. (USA)). pp 179-188 of In Radiation-induced leukemogenesis and related viruses. Duplan, J.F. (ed.). Amsterdam, Netherlands; North-Holland (1977).

From INSERM symposium no. 4; Bordeaux, France (7 - 9 Dec 1976).

A model of endogenous virus induction in AKR-strain mouse cells, based on two distinct types of alterations in cellular or proviral DNA, is presented. The first type are nonrepairable alterations such as those caused by the incorporation of halogenated pyrimidines; the second type are repairable lesions such as those caused by irradiation or certain chemicals other than pyrimidines. The production of nonrepairable lesions leads to the formation of a stable, proviral state which is dependent upon cell division for complete virus expression. A stable provirus intermediate state is not demonstrable in mouse cells induced by treatments which cause repairable lesions since replication of damaged or altered DNA must occur before the lesions are removed by repair synthesis. Experimental support for this model is based upon the following observations: (a) enhancement of induction is observed if lesions are introduced during cellular DNA synthesis; (b) quinacrine, which is an inhibitor of repair synthesis, increases the observed level of radiation induction; and (c) incorporation of 5-iodo-2'-deoxyuridine during repair of DNA appears to 'stabilize' lesions which would otherwise be removed by repair synthesis, and increases the level of virus induction.

RADIATION EFFECTS ON PLANTS

BASIC STUDIES

10995 (ORO—3408-24) **Three year progress report.** (Texas Univ., Austin (USA). Dept. of Zoology). Jul 1977. Contract EY-76-S-05-3408. 34p. Dep. NTIS, PC A03/MF A01.

Progress is reported on the following studies: x-ray and uv effects in photosynthetic organisms; effects of alcohols and oxygen concentration on transforming DNA; free radical studies; sensitization by metal ions; role of the solvated electron in radiation damage to cells; effectiveness of organic and inorganic compounds in sensitizing bacterial spores to high energy radiation; oxygen effects; radiosensitivity of enzyme systems in Chlorella; and effects of preirradiation of solutions on spores. (HLW)

10996 (ORO—4241-7) **Study of the biochemical effects of ionizing and nonionizing radiation on plant metabolism during development. Progress report, September 1, 1976—November 30, 1977.** Klein, W.H. (Smithsonian Institution, Rockville, Md. (USA). Radiation Biology Lab.). 1977. Contract EY-76-S-05-4241. 128p. Dep. NTIS, PC A07/MF A01.

Studies on spectral distribution and its control of plant growth and development included spectral quality measurements and biological responses. Spectral quality measurements consisted of spectral monitoring, the erythmal band, and testing of solar collectors. A physiological system for determining biological response was the photoperiodic response to the induction of flowering by long days in Hordeum vulgare; the design of the system was intended to test whether or not changes in the spectral distribution of natural daylight are capable of controlling photoperiodism. Biological responses were also determined by phytochrome measurements. Photostationary states of phytochrome were determined from white light grown tissue and the effect of changes in the red to far-red ratio on phytochrome was assessed. Experimental results are reported for studies on effects of pulsed light on plant productivity. (HLW)

RADIATION EFFECTS ON ANIMALS

MAN

10997 (NUREG—0322) **Ninth annual occupational radiation exposure report, 1976.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Management Information and Program Control). Oct 1977. 41p. NTIS $4.50.

Data are summarized on the occupational radiation exposure of personnel of U. S. nuclear facilities during 1976. The data on external and internal exposure to airborne radioactive materials were obtained from reports submitted by all NCR licensees. Brief descriptions of incidents leading to overexposures are included.

10998 **Medical radiation exposure of pregnant and potentially pregnant women.** Washington, DC; National Council on Radiation Protection and Measurements (1977). 37p. (NCRP—54).

Sensitivity to ionizing radiation is greater during intrauterine stages of development than at other stages in the life of the mammalian organism. For this reason, the NCRP recommends special care in patient selection in certain cases of diagnostic radiology and nuclear medicine diagnostic procedures. For women of child-bearing capacity, the physician requesting a radiological or nuclear medicine examination involving the lower abdominal or pelvic region should ascertain whether the patient is, or could be, pregnant. Further, the NCRP recommends that physicians tell their premenopausal patients that, if they are likely to have nuclear medicine studies or x-ray examinations of the lower abdomen, it is generally advisable that they not run a risk of pregnancy until two months after the studies are carried out. Modification of an examination for dose reduction is warranted only if it reasonably can be done without significant jeopardy to the medical care of the patient and/or her unborn child.

VERTEBRATES

REFER ALSO TO CITATION(S) 10984

10999 **Appearance of the multipotential hemopoietic stem cell.** van Bekkum, D.W. (Radiological Inst. TNO, Rijswijk, Netherlands). pp 3-10 of In Experimental hematology today. Baum, S.J.; Ledney, G.D. (eds.). New York; Springer-Verlag (1977).

From Proceedings of the International Society for Experimental Hematology; Washington, District of Columbia, USA (17 Aug 1976).

See CONF-760850—.

The development of the concept of the existence of the pluripotential HSC is largely based on the discoveries made 20 to 25 years ago to protect lethally radiated animals with hemopoietic cell suspensions. The functional description of the pluripotential HSC, and the discovery of a methodology to enumerate them, has permitted the development of techniques for concentrating HSC. This led to the identification of a morphologic entity in mouse bone marrow which is a realistic candidate for the HSC. Cells with similar morphologic characteristics were subsequently observed in enriched fractions of monkey and human bone marrow. Experimental results are presented here for enumerations in rat bone marrow using spleen colony assays in rats and mice. For both assays the seeding efficiency factors, f, have been determined, so that the HSC content of various rat HSC concentrates could be calculated. The HSC content in rat bone marrow is estimated to be 0.7 percent. Electron microscopic inspections of HSC concentrates obtained by discontinuous albumin gradient centrifugation revealed cells with similar morphologic characteristics as previously described for mouse bone marrow HSC. The numbers of these cells counted agreed satisfactorily with the calculated numbers of HSC, except for the most enriched fractions, where underestimates were obtained with the morphologic method. This discrepancy may be due to a not-yet-identified systematic error, or to different morphologic characteristics of G_0 and cycling HSC.

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

REFER ALSO TO CITATION(S) 10966

11000 (DP—1455, pp 221-222) **Aids for the rapid assessment of environmental releases to support emergency response.** Cooper, R.E. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Graphical data were compiled and incorporated into an emergency procedures manual to provide a rapid and accurate assessment of hazardous conditions. The data are organized within the emergency procedures manual in a manner intended to provide efficient indexing for rapid access to the appropriate graph. (HLW)

11001 (DP—1455, pp 225-228) **Extending emergency response capabilities to estimate doses from gamma rays.** Cooper, R.E.; Bailey, C.E. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

A confinement system in each of the production reactors at the Savannah River Plant (SRP) would limit the release of radioactive material from the reactor building in the event of an accidental release from the reactor. High efficiency particulate air (HEPA) filters would retain almost all particulate material, and charcoal beds would sorb most of the iodine. The release of radioactive material from the building through the stack would thus consist primarily of noble gases (xenon and krypton). Two programs (ERGAM and PUFGAM) have been made available through the WIND system to extend the emergency response capabilities to include calculations of whole-body gamma doses. These computer programs are used to estimate integrated wholebody gamma dose and dose rate as a function of downwind distance in the unlikely event of a reactor accident involving the melting of fuel and a subsequent release of radioactive gases to the atmosphere.

11002 (ORNL-tr—4464) **Therapeutic agents for radioactive detoxification (Ca-DTPA versus Zn-DTPA).** Planas-Bohne, F. Translated by T.W. Appich, Jr. from *KFK Nachr.;* 8: No. 1, 3-5(1976). 6p. Dep. NTIS, PC A02/MF A01.

Of the two DTPA salts, Zn-DTPA can generally be better tolerated than Ca-DTPA, especially when administered over a protracted period. In a long-term test with therapeutic doses neither of the two substances caused toxic side-effects. When administered immediately after transuranium elements are incorporated, Ca-DTPA is considerably more effective than Zn-DTPA; in the case of delayed application, the two chelates are equally effective. The above-described studies are intended, as mentioned initially, to aid in developing an optimum treatment system for cases of radioactive incorporation in man. It is possible to assume that the type of toxic side effects of the chelating agents in man will be the same as in the test animals since the same essential trace metals play a role in the same metabolic systems and therefore the elimination of these metals must lead to basically uniform disorders in man and test animals. Therefore, on the basis of the results obtained by us on rats the following basic treatment recommendations can be given: if therapy can be initiated immediately or with only a short delay after the incorporation of transuranium elements, then in healthy individuals Ca-DTPA should be preferred. Later treatment can be continued even with Ca or Zn-DTPA, as desired. In all cases in which the maintenance of a higher chelate concentration in the blood is desired over a longer period of time, for instance in treating a wound depot, however, Zn-DTPA should be used.

ANIMALS

11003 (DP—1455, pp 19-22) **Plutonium content in deer in the southeastern United States.** Kirkham, M.B. (Univ. of Massachusetts, Amherst); Corey, J.C. May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

The objective was to determine the distribution of plutonium in tissues of deer foraging on natural vegetation in the southeastern United States. The deer were obtained from North Carolina, Georgia, Alabama, and the Savannah River Plant (SRP) in South Carolina. Nuclear fuel reprocessing plants and global fallout are the primary sources of plutonium at SRP. Plutonium analyses of deer indicate that the plutonium content of onsite deer muscle is similar to values in offsite deer.

11004 **Prediction of the health effects of inhaled transuranium elements from experimental animal data.** Bair, W.J.; Thomas, J.M. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). pp 569-584 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

See CONF-751105—.

Although animal experiments are conducted to obtain data that can be used to predict the consequences of exposure to alpha-emitting elements on human health, scientists have been hesitant to project the results of animal experiments to man. However, since a human data base does not exist for inhaled transuranics, the animal data cannot be overlooked. The paper describes the derivation of linear non-threshold response relationships for lung cancer in rats after inhalation of alpha-emitting transuranium elements. These relationships were used to calculate risk estimates, which were then compared with a value calculated from the incidence of lung cancer in humans who had been exposed to sources of radiation other than the transuranics. Both estimates were compared with the estimated cancer risk associated with the annual whole-body dose limit of 5 rems for occupational exposure. The rat data suggest that the risk from a working lifetime exposure of 15 rem/a to the lungs from transuranium elements may be 5 times the risk incurred with a whole-body exposure of 5 rem/a, while the human data suggest the risk may be less. Since the histological type of plutonium-induced lung cancer that occurs in experimental animals is rare in man, the use of animal data to estimate risks may be conservative. Risk estimates calculated directly from the results of experiments in which animals actually inhaled transuranic particles circumvent such controversial issues as 'hot particles'.

11005 (BNWL-tr—262) **Grafts, in athymic mice, or pulmonary tissue of rats contaminated with plutonium oxide.** Nolibe, D.; Masse, R.; Fritsch, P.; Lafuma, J. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 13 Sep 1977. Translation of IAEA-SM-202/403. (CONF-751126—8). 19p. Dep. NTIS, PC A02/MF A01.

From IAEA international symposium on biological effects of low level radiation pertinent to protection of man and his environment; Chicago, Illinois, USA (3 Nov 1975).

Pulmonary fragments from control rats (Wistar) of varying age and contaminated with PuO_2 were grafted in an immunodeficient medium onto mice and histocompatible rats. In both cases, the authors observed lesions presenting the histological characteristics of pulmonary cancer in rats; proliferation, however, remained discrete. After grafting on the athymic mice, the lungs of the control animals exhibited a percentage of tumoral-type differentiations which increased with age. In the contaminated rats, for an initial pulmonary burden of 10 nCi and cumulative doses of between 6×10^8 and 38×10^9 a/g of lung, the grafts showed a clear increase in lesions of this type. Their frequency increased with the total dose delivered. On the other hand, if the dose delivered during a three-month period varied from 2×10^8 to 50×10^9 a/g of lung, the maximum proliferation was observed at the lowest doses. Furthermore, the histological nature of the proliferations varied with the dose delivered. This transplantation technique would appear to show the existence of lesions which are not yet overt and which are a consequence of either aging or alpha irradiation. The authors discuss the meaning of these lesions and the immunological component of the phenomenon.

11006 **Radioactive mercury vapor generating and exposing system for small scale animal experiments.** Sugata, Y. (Univ. of Rochester, NY); Clarkson, T.W.; Magos, L. *Am. Ind. Hyg. Assoc. J.;* **37**: 449-452(Aug 1976).

An apparatus is described for exposing small animals to high specific activity elemental mercury vapor. The vapor is generated by reduction of mercury chloride labelled with the ^{203}Hg isotope. The vapor is carried by a constant stream of air into the exposure chamber. The method has been used to expose rats or mice to constant air concentrations of mercury vapor in the range from 0.008 to 0.32 mg/m^3. The specific activity of the mercuric chloride used in the study was approximately 1.8 mCi/mgHg. This is sufficiently high to allow measurement of tissue deposition of mercury after an exposure period of only 30 minutes.

PLANTS

REFER ALSO TO CITATION(S) 10969

NUCLIDE KINETICS AND TOXICOLOGY

MAN

REFER ALSO TO CITATION(S) 10997, 10998

11007 **Statistical evaluation of the radiotoxicity of inhaled plutonium in insoluble form.** Cave, L. (Pollution Prevention (Consultants) Ltd., Crawley (UK)); Freedman, L. (Medical Research Council, London (UK)). pp 547-565 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

See CONF-751105—.

The purpose of the paper is to analyse statistically the available human data relating to plutonium toxicity to see whether two outstanding uncertainties can be resolved: (1) whether there is a marked increase in toxicity with size of particle, due to a 'hot particle' effect; (2) whether the commonly used value of 0.016μCi for the maximum permissible lung burden for occupational workers is an adequate interpretation of the ICRP recommendation that the dose to the lung should not exceed 15rem/a. Of the human data available, only that for the group of 25 LASL workers who acquired substantial lung burdens during 1944/45 can, at present, make a substantial contribution to the statistical analysis. Data relating to particle size distribution in plutonium handling facilities is reviewed. This review shows that it is reasonable to assume that the distributions to which these workers were exposed was reasonably representative of those that might be encountered in the normal operation of such facilities, and in accident conditions at such plants or at such nuclear power stations. The statistical methods employed provide estimates of 'risk factors' in terms of unit activity burden or per particle. They are able to take account of substantial random errors in the basic data and to give an appropriate weight to various hypotheses as to the extent, if any, of a 'hot particle' effect. The results of the analysis give little support to the view that there is a substantial 'hot particle' effect. Some published estimates of 'risk per particle' appear to be too large by factors of at least 1000. The total exposure represented by the available human data is not yet large enough to substantiate fully, on a statistical basis, the value of 0.016μCi for the maximum permissible lung burden. However, regarded as a 'best estimate' this value should not be too high by a factor of more than 15 or, by a factor of more than 40 at the 95% upper confidence level.

ANIMALS

11008 (COO—119-252) **Research in radiobiology. Annual report of work in progress in the internal irradiation program.** Jee, W.S.S. (Utah Univ., Salt Lake City (USA). Coll. of Medicine). 31 Mar 1977. Contract EY-76-S-02-0119. 313p. Dep. NTIS, PC A14/MF A01.

Separate abstracts were prepared for 13 sections of this report. A list is included of publications during the time period covered by this report.

11009 (COO—119-252, pp 9-151) **Preface to the injection tables.** 31 Mar 1977.

In Research in radiobiology. Annual report of work in progress in the internal irradiation program.

Twelve groups of dogs received intravenous injections of various doses of ^{226}Ra, ^{239}Pu, ^{228}Ra, ^{228}Th, ^{90}Sr, ^{241}Am, ^{249}Cf, or ^{252}Cf at approximately 17 months of age. The animals were euthanized when death appeared imminent. Data are presented on the calculated radiation dose to the skeleton and pathological changes observed at autopsy.

11010 (COO—119-252, pp 152-161) **Quantitative histology of trabecular bone surfaces of young adult beagles.** Kimmel, D.B.; Jee, W.S.S. 31 Mar 1977.

In Research in radiobiology. Annual report of work in progress in the internal irradiation program.

Methods are described that were used for tritiated thymidine autoradiographic studies of changes in trabecular bone surfaces of young adult beagle dogs injected with known amounts of ^{239}Pu. Cell density, cell nucleus size, cell nucleus distance from bone surface, and DNA synthesis were measured microscopically following eleven months exposure time of the autoradiogram.

11011 (COO—119-252, pp 162-171) **^{239}Pu standards for quantitative neutron-induced autoradiography.** Smith, J.M.; Atherton, D.R.; Wronski, T.J.; Jee, W.S.S. 31 Mar 1977.

In Research in radiobiology. Annual report of work in progress in the internal irradiation program.

The present study deals with the preparation of ^{239}Pu standards for neutron bone tissue autoradiography and the calibration of these standards with respect to uranium reference standards. Known concentrations of ^{239}Pu were prepared in methyl methacrylate and Bioplastic casting resin bars. Wafers sawed from these bars served as standards. Solid state nuclear tract detectors (Lexan polycarbonate) were used to record fission fragment tracks after the standards were exposed to a thermal neutron flux. The original bars were found to contain a uniform distribution of ^{239}Pu. To confirm the concentration of ^{239}Pu in the wafers, the induced track density from the ^{239}Pu standards was compared with that from uranium reference standards. The average fission fragment detection efficiency for all of the standards was 0.51.

11012 (COO—119-252, pp 172-190) **Preliminary report on the correlation of the rate of trabecular bone turnover and ^{239}Pu concentration on trabecular surfaces with the incidence of osteosarcoma at selected skeletal sites.** Wronski, T.J.; Smith, J.M.; Jee, W.S.S. 31 Mar 1977.

In Research in radiobiology. Annual report of work in progress in the internal irradiation program.

An attempt to identify factors which contribute to the nonuniform skeletal distribution of ^{239}Pu-induced osteosarcomas is currently underway. Two possible factors investigated in this study were the rate of trabecular bone turnover and ^{239}Pu concentration on trabecular surfaces. Two 17 month old beagles, injected with approximately 0.016 μCi/kg of monomeric ^{239}Pu-citrate and sacrificed at 28 and 56 days post-injection respectively, were studied. A third beagle served as a control. The lumbar vertebra, pelvis, and proximal humerus, each of which exhibits a high incidence of osteosarcoma, were found to have a high rate of trabecular bone turnover. The proximal ulna and distal humerus, which are infrequent sites of osteosarcoma, had a low rate of trabecular bone turnover. In the beagles injected with ^{239}Pu, the rate of trabecular bone turnover was depressed when compared with that of the control.

11013 (COO—119-252, pp 191-195) **Early distribution of ^{238}Pu in the liver of a Cynomolgus monkey.** Bruenger, F.W.; Durbin, P.; Atherton, D.R.; Stevens, W. 31 Mar 1977.

In Research in radiobiology. Annual report of work in progress in the internal irradiation program.

The intraorgan distribution of ^{239}Pu in the perfused liver of a Cynomolgus monkey at 1 day after injection was studied by differential centrifugation and zonal centrifugation. The perfusate was analyzed for molecular association of Pu. Total liver deposition was 43.2% of the injected dose and after correction for blood contamination, 1.6% of this was found in the perfusate. In liver homogenates, most of the Pu was associated with the microsomal- and soluble fractions of low density whereas little was found in the mitochondrial and lysosomal fractions. In the perfusate, the largest fraction of the Pu was bound to a heat stable protein which had a pI between 4.65 and 4.85.

11014 (COO—119-252, pp 196-209) **Synthesis and testing of partially lipophilic polyaminocarboxylic acids.** Bruenger, F.W.; Neilson, E.R.; Atherton, D.R.; Stevens, W. 31 Mar 1977.

In Research in radiobiology. Annual report of work in progress in the internal irradiation program.

Polyaminocarboxylic acids derived from diethylenetriamine and triethylenetetramine containing a lipophilic group have been synthesized. Compounds derived from triethylenetetramine were more effective in removing Pu in vitro from liver constituents labeled in vivo than those derived from diethylenetriamine. Alkylated acids showed a greater efficacy than their nonsubstituted counterparts. The greater efficacy was confirmed in a pilot experiment in rats with aged burdens of ^{241}Am. The relative effectiveness of a number of structurally related chelons as well as combinations of chelating agents for the removal of ^{239}Pu and ^{241}Am from high molecular weight liver proteins has been reported earlier. The efficacy of a chelating agent for the decorporation of potentially harmful metal ions is dependent on three factors: the affinity of the chelon for the respective metal ion, the ability of the chelon to reach

the site of metal deposition in vivo and the toxicity of the agent itself. Present experiments are directed towards the synthesis and testing of agents which have balanced hydrophilic and lipophilic properties.

11015 (COO—119-252, pp 211-222) **Retention and distribution of ^{239}Pu in beagles injected at 3 months of age.** Stevens, W.; Atherton, D.R.; Bruengr, F.W.; Stover, B.J.; Gleason, M.; Buster, D. 31 Mar 1977.

In Research in radiobiology. Annual report of work in progress in the internal irradiation program.

This report summarizes the metabolism of ^{239}Pu in dogs injected as juveniles with 2.9 μCi ^{239}Pu/kg.

11016 (COO—119-252, pp 223-227) **Deposition of ^{239}Pu, ^{226}Ra, ^{233}U and ^{241}Am in the gonads of beagles and rats.** Stevens, W.; Atherton, D.R.; Bruenger, F.W.; Buster, D.; Bates, D. 31 Mar 1977.

In Research in radiobiology. Annual report of work in progress in the internal irradiation program.

Gonads of beagles and rats were collected for radiochemical analysis of ^{239}Pu, ^{226}Ra, ^{233}U, and ^{241}Am and for autoradiography. Preliminary results of radiochemical analysis are presented. Data were obtained from dogs injected at 18 mo of age (young adults), dogs injected at 3 mo of age (juveniles) and one dog injected at 5 years of age. Most of the dogs were injected intravenously with the standard injection solution containing the respective radionuclide in 0.08 M citrate buffer. Another group of animals was injected with particulate Pu (polymeric) at 18 mo of age. Male, Sprague-Dawley rats, weighing 250 g, were injected with 0.3 μCi ^{239}Pu/kg in 0.08 M citrate buffer and were sacrificed from 3 to 31 days later. Data are given as % injected dose per gram of tissue and the dose rate (millirad/day) resulting from that concentration of nuclide at the time of observation. Dose rates to the liver and to a specimen of skeletal muscle from the same animal are included for comparison.

11017 (COO—119-252, pp 256-271) **Zn-DTPA administered by slow-release implant.** Calder, S.E.; Taylor, G.N.; Lloyd, R.D.; Petersen, R.V.; Atherton, D.R.; Mays, C.W. 31 Mar 1977.

In Research in radiobiology. Annual report of work in progress in the internal irradiation program.

Because of the short biological retention half-time of Zn-DTPA and the desirability of a maintained blood level of the chelate, alternative modes of its administration were explored. Zn-DTPA labeled with ^{65}Zn was dried and ground to a fine powder and incorporated into implants of various combinations of cholesterol, polyethylene glycol 4000, beeswax, and peanut oil in order to produce a slow release of the chelation agent. One group of pellets, placed subcutaneously in the dorsal neck of young adult beagles, produced daily release rates of from 0.5 to 41% of the implanted DTPA, increasing with the percentage of polyethylene glycol 4000 in the pellet. When ^{241}Am citrate was injected intravenously into beagles preimplanted with a DTPA pellet, the fraction of the injected ^{241}Am excreted in the first 24 hours increased from 9% (control) to 38% (2.9 μmole DTPA/kg/day) to 84% (70 μmole/kg/day).

11018 (COO—119-252, pp 272-287) **^{224}Ra toxicity from a pilot study in beagles.** Mays, C.W.; Lloyd, R.D.; Taylor, G.N.; Atherton, D.R. 31 Mar 1977.

In Research in radiobiology. Annual report of work in progress in the internal irradiation program.

Toxicity data are reported for 20 beagles given single intravenous injections of ^{224}Ra in 1963 or 1968. The injection of 1 μCi ^{224}Ra/kg gave an average skeletal dose of about 54 rad in young adult beagles. Two dogs died of acute radiation sickness, 6 with bone sarcomas, 6 from other causes, and 6 were still alive on 31 March 1977. The acutely lethal dosage (LD/sub 50/30)/ for a single injection of ^{224}Ra in young adult beagles seems to lie between 10 and 20 μCi ^{224}Ra/kg, with an average skeletal dose between 500 and 1000 rad.

11019 (COO—119-252, pp 288-305) **Removal of systemically absorbed ^{109}Cd in mice using a combination of chelating agents.** Boseman, J.J.; Lloyd, R.; Mays, C.W. 31 Mar 1977.

In Research in radiobiology. Annual report of work in progress in the internal irradiation program.

Cadmium metal and its compounds constitute an energy-related pollutant which can have serious teratogenic effects on the fetus. A pilot study was made to evaluate the effectiveness of a few combinations of selected chelating agents in removing systemically absorbed ^{109}Cd from mice. The agents were Na_3Zn diethylenetriaminepentaacetate (ZnDTPA), penacillamine (PA), and 2,3 dimercaptopropanol (British Anti Lewisite, or BAL). C57BL/Do mice were each injected intraperitoneally (i.p.) at 10-12 weeks of age with approximately 1 μCi ^{109}Cd and allowed to stabilize for three days. The mice were then treated daily, except weekends. Groups of 6 male and 6 female mice were assigned to each one of the following treatments: physiological saline; ZnDTPA; ZnDTPA + PA; ZnDTPA + BAL; and ZnDTPA + PA + BAL. Total body ^{109}Cd retention was determined periodically. Measurement of the ^{109}Cd content in kidneys, livers, and femurs of mice from each of the groups indicated that the retention in all 3 tissues of mice treated with ZnDTPA + BAL or ZnDTPA + PA + BAL was significantly less by factors of about 19, 3, and 3, respectively, than that in mice not given BAL.

11020 **Protection of the thyroid gland in the event of releases of radioiodine.** Washington, DC; National Council on Radiation Protection and Measurements (1977). 65p. (NCRP—55).

A major protective action to be considered after a serious accident at a nuclear power facility involving the release of ^{131}I is the use of stable iodide as a thyroid blocking agent to prevent thyroid uptake of radioiodines. For greatest effectiveness, the blocking agent should be administered within a few hours after an accident. Since reliable radiation monitoring data may not be available that quickly, the decision to administer stable iodide should be based on a pre-planned estimate of the probable degree of contamination from the accident. For people beyond the immediate vicinity of the reactor, the decision to administer stable iodide, to instruct them to remain indoors, or to evacuate them would depend on the type of accident, on preplanned estimates of release, on wind direction and, later, on monitoring data as they become available. An extensive review of mass evacuation shows that masses of up to 150,000 persons have been evacuated safely in natural or potential man-made disasters. These evacuations have been carried out within hours without loss of life, panic or looting. Based on these experiences, urban as well as rural populations can be evacuated promptly and safely.

11021 **Cesium-137 from the environment to man: metabolism and dose.** Washington, DC; National Council on Radiation Protection and Measurements (1977). 53p. (NCRP—52).

Data on ^{137}Cs present in world-wide fallout are reviewed with reference to movement in the environment and food chains and its entry into humans. Seasonal fluctuations in deposition and in dietary levels, effects of soil type on the levels in vegetation, the early relations of these levels to deposition, and the later emergence of evidence of root uptake by plants and the time lag between deposition and dietary levels have been noted. Particular environments and ecosystems showing levels higher than usual have been indicated. In particular, estimates of ^{137}Cs in the pasture-cow-milk-man food chain appear to be reasonable. Several recent predictive studies now make it easier to follow a monitoring program and detect early changes that might indicate differences between various models of particular environmental circumstances. Dosimetric data obtained from studies of fallout and from laboratory experiments indicate that the elimination half-times for infants and children are significantly shorter than for normal adults. The same is true for the pregnant female, on the average, and for individuals subject to certain muscle wasting diseases. Also, the fraction of photon energy escaping from the body is somewhat larger for infants and children due to their smaller body sizes. Thus, the assumptions concerning the dose that would follow local deposition on pasture appear to be reasonable for the average adult. However, one would expect somewhat lower doses (on the average) for infants, pregnant women, and muscular dystrophy patients. The maximum permissible levels for concentrations of ^{137}Cs in air and water for occupational exposure do not differ significantly from previously recommended levels. A small number of studies of effects of ^{137}Cs on animals suggests that the whole body of the animal is substantially irradiated, and the results of these studies are in general agreement with other studies of effects of low-LET radiation.

PLANTS

11022 (DP—1455, pp 23-26) **Uptake of three isotopes of plutonium from soil by sweet corn grown in a growth chamber.** Hersloff, L.W. (Univ. of Georgia, Athens); Corey, J.C. May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

A gamma-emitting isotope of plutonium for simulating ^{238}Pu and ^{239}Pu behavior in the environment would eliminate the high cost of sample preparation necessary for detecting alpha particles. To date, selected tracers for this purpose have not been satisfactory; however, the availability of ^{237}Pu has provided an additional candidate tracer. ^{237}Pu has been used to trace ^{239}Pu in metabolic studies of plutonium distribution in, and excretion by, dogs and rats and to determine the distribution coefficient of plutonium between sediment and sea water. The suitability of ^{237}Pu as a tracer for ^{238}Pu and ^{239}Pu in environmental systems was determined using a plant-soil system. These three isotopes were compared by measuring their uptakes by sweet corn. A nitrate solution containing all three isotopes was added to the soil. The apparent availability of the three isotopes differed: ^{237}Pu was more available than ^{238}Pu, which was more available than ^{239}Pu. The quantity of ^{237}Pu in the standing crop, on a mass basis, closely approximated that of ^{238}Pu.

11023 (DP—1455, pp 187-192) **Deposition velocities for ^{3}HHO, $^{14}CO_2$, $^{131}I_2$, and $CH_3{}^{131}I$ on surfaces of vegetation.** Murphy, C.E. Jr. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

The purpose of this study was to calculate deposition velocities of tritiated water, carbon dioxide, iodide, and methyl iodide gases on local vegetation adjacent to a reprocessing plant for spent reactor fuels. The information is required because an individual's potential dose from exposure to these airborne materials can be substantially reduced when removal processes are active, but the potential dose to man from ingestion and other pathways may increase. The calculated deposition velocities ranged from 0.10 to 2.04 cm/sec depending on the vegetation and the climatic conditions.

MICROORGANISMS

11024 (DP—1455, pp 31-34) **Conversion of gaseous molecular tritium to tritiated water in pine needles.** Murphy, C.E. Jr. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Vegetation near nuclear facilities which release tritium to the atmosphere has elevated concentrations of tritiated water (HTO) in the free water when compared with HTO concentrations in free water in vegetation grown at some distance from the facilities. Because some of the tritium released from these facilities is in the form of HTO vapor, it has been assumed that the elevated concentrations were due to direct exchange of vegetation water with HTO in the atmosphere. However, in some cases the tritium concentration in the free water did not seem to be in equilibrium with the tritium concentration in the atmosphere. Exposures of pine needles show that absorption of molecular tritium takes place in the needles. The absorbed tritium is incorporated both in the tritiated water and in the dry fraction of the needles.

11025 Plutonium uptake by a soil fungus and transport to its spores. Beckert, W.F.; Au, F.H.F. (Environmental Protection Agency, Las Vegas, Nev. (USA). Environmental Monitoring and Support Lab.). pp 337-343 of In Transuranium nuclides in the environment. Vienna; IAEA (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

See CONF-751105—.

Three concentrations of plutonium-238 nitrate, citrate and dioxide were each added to separate plates of malt agar buffered to pH 2.5 and 5.5 to determine the uptake of plutonium from these chemical forms and concentrations by a common soil fungus, Aspergillus niger. After inoculation and incubation, the aerial spores of Aspergillus niger were collected using a technique that excluded the possibility of cross-contamination of the spores by the culture media or by mycelial fragments. ^{238}Pu was taken up from all three chemical forms and transported to the aerial spores of Aspergillus niger at each concentration and at both pH levels. The specific activities of the spores grown at pH 5.5 were generally at least twice those of the spores grown at pH 2.5. The uptake of plutonium from the dioxide form was about one-third of that from the nitrate and citrate forms at both pH levels. The term 'transport factor' is used as a means to compare the transport of plutonium from the media to the fungal spores; the concentration-independent transport factor is defined as the specific activity of the spores divided by the specific activity of the dry culture medium. Though the transport factors were less than 1, which indicates discrimination against the transport of ^{238}Pu from the culture media to the spores, these findings suggest that this common soil fungus may be solubilizing soil-deposited plutonium and rendering it more biologically available for higher plants and animals.

THERMAL EFFECTS

PLANTS

11026 Morphological aberrations in Typha populations in a post-thermal aquatic habitat. Suda, J.R.; Sharitz, R.R.; Straney, D.O. (Savannah River Ecology Lab., Aiken, SC). *Am. J. Bot.;* **64**: No. 5, 570-575(1977).

Morphological aberrations in Typha populations inhabiting a once thermally stressed aquatic system on the Savannah River Plant in South Carolina were investigated by using both morphological and enzymatic procedures. No evidence of hybridization or introgression between T. latifolia and T. domingensis was found. Exposures of these populations to post-thermal conditions and low levels of radiocesium were judged insignificant in contributing to the morphological differences observed. Both genotypic flexibility and plasticity appear to be critical factors in the adaptation of Typha to varied environments.

VERTEBRATES

REFER ALSO TO CITATION(S) 10985

11027 Comparison between results obtained with in vitro and in vivo methods for study of the effects of thermal variations on intestinal absorption of glycine by the rainbow trout (Salmo gairdnerii R.). Boge, G.; Rigal, A.; Peres, G. *Cah. Lab. Hydrobiol. Montereau;* No. 3, 15-20(Nov 1976). (In French).

A comparative study about thermal effects on intestinal absorption of ^{14}C Glycine (0.5 mM) has been undertaken with in vitro and in vivo technics. An "in situ" original intestinal perfusion method has been used for this work. In vitro, the action of temperature on total absorption of ^{14}C Glycine (0.5 mM) is effective after $10^{0}C$, in particular on midgut. In vivo, this action is stronger at low temperatures. The existence of a blood control which is dependent on a medium temperature modification has been proposed to explain these differences.

11028 Associated effects of hypoxia and thermal modifications on in vitro intestinal absorption of ^{14}C glycine by rainbow trout (Salmo gairdnerii R.). Boge, G.; Rigal, A.; Peres, G. *Cah. Lab. Hydrobiol. Montereau;* No. 3, 21-24(Nov 1976). (In French).

The action of hypoxia on intestinal absorption of ^{14}C Glycine (0.5 mM) has been studied by means of the "intestinal stripes" method. The incubations have been conducted at $20^{0}C$ during 60 minutes. Hypoxia minimizes thermal effects on total ^{14}C Glycine (0.5 mM), and on the accumulation of this amino acid in the different intestinal tissues. Thermal effect on water movements, studied by weighing the stripes before and after incubation, is reduced in a similar way.

11029 Resistance of roach (Rutilus rutilus L.) to sudden temperature change. Barbier, B.; Pascal, M. *Cah. Lab. Hydrobiol. Montereau;* No. 3, 25-34(Nov 1976). (In French).

Temperature resistance tests were performed on Roach (Rutilus rutilus L.) which were submitted for 48 hours to temperature steps. It was found that the lethal temperature increase with the acclimatization (at 50% mortality) is $36.2^{0}C$. A graph is given of the accepted temperature steps for 10, 50 and 90% mortality of Roach.

11030 Relationship between lethal and acclimatization temperatures for freshwater fish. A data-plotting method. Khalanski, M. *Cah. Lab. Hydrobiol. Montereau;* No. 3, 35-42(Nov 1976). (In French).

The experimental data on the variation of the lethal temperature (TL_{50}) as a function of acclimatization temperature are represented in a chart. The chart enables us to compute with a known deviation range the temperature step over the acclimatization temperature value for a 50% mortality for three freshwater species of fish.

11031 Effect of artificially-induced water temperature rise on physiological parameters of two members of the teleostei group: roach and perch. Parent, J.P.; Bouche, G.; Vellas, F. *Cah. Lab. Hydrobiol. Montereau;* No. 3, 5-14(Nov 1976). (In French).

The influence of heated effluents from a power station on the physiology of roach (Leuciscus rutilus L.) and perch (Perca fluviatilis L.) has been studied. Whole body and gonad weights, lipid and protein concentration in blood, so as lipid, protein and RNA in liver and muscle have been determinated. In our experimental conditions (from March to July), our results suggest that the biological cycle of these species is shortened by an increase of temperature.

CHEMICALS METABOLISM AND TOXICITY

REFER ALSO TO CITATION(S) 9675

CELLS

REFER ALSO TO CITATION(S) 11035

MICROORGANISMS

REFER ALSO TO CITATION(S) 9676

PLANTS

REFER ALSO TO CITATION(S) 9656

11032 Evidence for repair of ozone induced membrane injury: alteration in sugar uptake. Sutton, R.; Ting, I.P. (Univ. of California, Riverside). *Atmos. Environ.;* **11**: No. 3, 273-275(1977).

After short term ozone exposure (0.6 to 0.8 ppM O_3 for 1 h) of pinto bean plants, leaf discs punched from the primary leaves show an enhanced uptake of 2-deoxyglucose. We assume the latter is the result of an alteration in membrane selectivity or permeability. In leaves which are too young to show visible ozone induced necrosis, after 5 days in a normal light regime the increased uptake returned to the control, an indication of natural repair of ozone injury. Continuous light or glucose treatment enhances the rate of repair whereas continuous dark delays the repair. We assume these observations indicate the presence of an energy dependent repair process for ozone induced injury.

INVERTEBRATES

11033 Natural variability in distribution of an intertidal population of Macoma balthica subject to potential oil pollution at Port Valdez, Alaska. Myren, R.T.; Pella, J.J. (National Marine Fisheries Service, Auke Bay, Alaska). *Mar. Biol.;* **41**: No. 4, 371-382(1977).

Natural variability in the abundance of an intertidal population of the lamellibranch Macoma balthica (Linnaeus, 1758) was measured during 1971 and 1972 in a study area near the proposed oil storage and tankship loading facility at the southern terminus of the Trans-Alaska pipeline in Port Valdez, Alaska. M. balthica were divided for analysis into a large and a small size category. Small temporal changes in population densities throughout the entire study area were detected for both size categories over several of the 7 sampling times of the 2-year period. Large and persistent differences in density were found among elevation contour intervals for either size category; however, variations in the density profiles on elevation occurred among sampling times. Large M. balthica became more equitably distributed and the small category less equitably distributed among elevation contours over the 2-year period. Densities of both size categories were more stable at the higher elevations of the study site. Large M. balthica were more homogeneously distributed along a given elevation contour interval than the small category. Mobility and time available to redistribute at a horizontal location would explain the more homogeneous distribution of large M. balthica if competition for food resources exists.

VERTEBRATES

REFER ALSO TO CITATION(S) 9677

11034 Biomedical responses of rats to chronic exposure to dietary cadmium fed in ad libitum and equalized regimes. Cousins, R.J.; Squibb, K.S.; Feldman, S.L.; de Bari, A.; Silbon, B.L. (Rutgers—The State Univ., New Brunswick, NJ). *J. Toxicol. Environ. Health;* **2**: No. 4, 929-943(Mar 1977).

Forty 100 g male rats were fed, in groups of eight, either 0, 5, or 25 ppM cadmium in a purified diet for 14 wk. Three groups were fed each of the levels of cadmium on an ad libitum basis. Two other groups were fed either 0 or 5 ppM cadmium in amounts that were equalized to that consumed by the 25 ppM group fed ad libitum. Cadmium ingestion decreased daily diet consumption, weight gain, and terminal body weight. These parameters were not significantly different in rats whose diet consumption was equalized. Packed cell volume and serum iron as well as serum zinc were decreased in the rats fed 25 ppM cadmium. These effects were not related to diet intake. No major differences were observed in serum ceruloplasmin, glucose, protein, leucine aminopeptidase activity, or copper in any of the groups. Blood urea nitrogen and renal leucine aminopeptidase activity were decreased by cadmium ingestion in the rats fed ad libitum only. In contrast, serum alkaline phosphatase activity was elevated by cadmium in the equalized-intake groups only. Cadmium and zinc concentrations were elevated and the iron concentration was decreased in the kidney, liver, and intestinal mucosa of the cadmium-fed rats irrespective of level of diet consumption. The increased uptake of cadmium in these tissues was coincident with the increased content of the cadmium-binding protein, metallothionein, in the cytosol fraction. The results indicate that some parameters of chronic cadmium toxicity are associated with diet consumption whereas others are not.

MAN

REFER ALSO TO CITATION(S) 9678

11035 (CONF-7605160—, pp 123-165) **Genotoxic environmental pollutants.** Sawicki, E. (National Environmental Research Center, Research Triangle Park, NC). 1976.

From 1. symposium on management of residuals from synthetic fuels production; Denver, Colorado, USA (25 May 1976).

In Proceedings of the first symposium on management of residuals from synthetic fuels production.

A general review is given of chemical mutagens that present environmental hazards to man.

HEALTH AND SAFETY

11036 (CONF-770740—, pp 54-73) **AES computer plans.** Liverman, J.L. 1977.

From AESOP operations managers conference; Arlington, Virginia, USA (11 Jul 1977).

In Proceedings: AESOP conference.

The AES ADP program is divided into six categories for discussion: computer graphics, hardware support, data exchange between laboratories, networking, information stored on line in bibliographic abstract form, and advanced languages. Plans for acquisition and development in these areas are related. (RWR)

GEOSCIENCES

GEOLOGY AND HYDROLOGY

11037 (DP—1455, pp 55-58) **Results of pumping tests in shallow sediments in the separations areas.** Root, R.W. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

The values of hydraulic conductivity (as measured by slug testing) for the different formations overlap; but generally, the Upper Barnwell Formation sand lens has higher conductivity than the Lower Barnwell Formation; which has, in turn, a higher conductivity than the Middle Barnwell Formation. Also, the Upper McBean Formation has a generally higher conductivity than the Lower McBean Formation. However, the values obtained from slug tests are generally higher than those obtained for the same formation by either of the two pumping test methods. The data from drawdown and recovery tests indicate that the conductivity of the sand lens in the Upper Barnwell Formation is higher than the conductivity of the Middle Barnwell Formation. Also, the Upper McBean Formation appears to have a higher conductivity than the Lower McBean Formation.

11038 (DP—1455, pp 59-62) **Computer program to analyze aquifer test data.** Root, R.W.; Murphy, C.E. Jr. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Aquifer test data were analyzed by a variety of curve-fitting and slope-measuring techniques to provide hydrologic information about water-bearing subsurface material. The curves are graphs of analytical functions, and these functions can be fitted to the field data by statistical techniques. A computer program was written for fitting field data by a nonlinear least squares technique. This method rapidly evaluates the hydraulic variables of the modeling equations for large data sets.

11039 (DP—1455, pp 63-68) **Conceptual geohydrological model of the separations area.** Root, R.W.; Marine, I.W. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Subsurface drilling in and around the Separations Areas (F-Area and H-Area of the Savannah River Plant) is providing detailed information for a conceptual model of the geology and hydrology underlying these areas. This conceptual model will provide the framework needed for a mathematical model of groundwater movement beneath these areas. Existing information substantiates the presence of two areally extensive clay layers and several discontinuous clay and sandy-clay layers. These layers occur in and between beds of clayey and silty sand that make up most of the subsurface material. Within these sand beds are geologic units of differing hydraulic conductivity. For the present scale of the model, the subsurface information is considered adequate in H-Area, but additional drilling is planned in F-Area.

GEOPHYSICS

11040 Partial melting and electrical conductivity anomalies in the upper mantle. Shankland, T.J.; Waff, H.S. (Geosciences Group, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Geophys. Res.;* **82**: No. 33, 5409-5417(10 Nov 1977).

For mantle regions of anomalously high electrical conductivity (greater than 0.1 S/m) the bulk conductivity is modeled by effective medium theory as a basalt melt fraction within a mainly olivine matrix. In order for the highly conducting melt to affect the bulk conductivity it must form interconnections, so that the very

existence of mantle conductivity anomalies constitutes evidence for such interconnections. The inclusion of petrological data on the partial melting of peridotite strongly constrains the range of temperatures and melt fractions that can be used to yield an observed electrical conductivity. Thus from anomalous conductivities which are observed under rift zones, volcanic belts, geothermal areas, and beneath the oceans, it is possible to estimate both the temperature and the degree of partial melting. While other mechanisms for mantle conductivity enhancement may exist, e.g., contributions from contaminated grain boundaries or high volatile contents, these explanations associate a chemical differentiation in the mantle with thermal manifestations and in most cases create conditions that favor melting.

SEISMOLOGY AND TECTONICS

11041 (DP—1455, pp 69-74) **Savannah River Plant seismograph network.** Krapp, C.W. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

Although Charleston is the epicentral location of 92 percent of the earthquakes that occur in South Carolina, earthquakes do occur in other parts of South Carolina. No earthquakes have ever triggered the low-level alarms (acceleration greater than 0.005 G) in the reactor buildings at the Savannah River Plant (SRP), nor have they triggered the strong motion recorders (acceleration greater than 0.01 G). Thus, no useful seismic data have been collected at SRP on very small earthquakes that could have occurred in the general area. A project was authorized in late 1975 for the Savannah River Laboratory (SRL) to purchase, install, and operate a seismograph system at SRP. The SRP Seismograph Network became fully operational on August 6, 1976. This network was designed to provide a continuous record of any local seismic activity. Parameters obtained from the network will be epicentral location and magnitude, and possibly, depth to focus of the earthquake.

VOLCANOLOGY

11042 **Three-dimensional crust and mantle structure of Kilauea Volcano, Hawaii.** Ellsworth, W.L.; Koyanagi, R.Y. (U.S. Geological Survey, Cambridge, Massachusetts 02139). *J. Geophys. Res.;* **82**: No. 33, 5379-5394(10 Nov 1977).

Teleseismic P wave arrival times recorded by a dense network of seismograph stations located on Kilauea volcano, Hawaii, are inverted to determine lateral variation in crust and upper mantle structure to a depth of 70 km. The crustal structure is dominated by relatively high velocities within the central summit complex and along the two radial rift zones compared with the nonrift flank of the volcano. Both the mean crustal velocity contrast between summit and nonrift flank and the distribution of velocities agree well with results from crustal refraction studies. Comparison of the velocity structure with Bouguer gravity anomalies over the volcano through a simple physical model also gives excellent agreement. Mantle structure appears to be more homogeneous than crustal structure. The root mean square velocity variation for the mantle averages only 1.5%, whereas variation within the crust exceeds 4%. The summit of Kilauea is underlain by normal velocity (8.1 km/s) material within the uppermost mantle (12—25 km), suggesting that large magma storage reservoirs are not present at this level and that the passageways from deeper sources must be quite narrow. No evidence is found for substantial volumes of partially molten rock (5%) within the mantle to depths of at least 40 km. Below about 30 km, low-velocity zones (1—2%) underlie the summits of Kilauea and nearby Mauna Loa and extend south of Kilauea into a broad offshore zone. Correlation of volcanic tremor source locations and persistent zones of mantle earthquakes with low-velocity mantle between 27.5- and 42.5-km depth suggests that a laterally extensive conduit system feeds magma to the volcanic summits from sources either at comparable depth or deeper within the mantle. The center of contemporary magmatic production and/or upwelling from deeper in the mantle appears to extend well to the south of the active volcanic summits, suggesting that the Hawaiian Island chain is actively extending to the southeast.

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

11043 **Changes in seismic velocity and attenuation during deformation of granite.** Lockner, D.A.; Walsh, J.B.; Byerlee, J.D. (U.S. Geological Survey, Menlo Park, California 94025). *J. Geophys. Res.;* **82**: No. 33, 5374-5378(10 Nov 1977).

The seismic velocity and attenuation were measured for P, S_1, and S waves traveling through a sample of Westerley Granite as it was deformed to failure under a confining pressure of 500 bars. All waves traveled in a direction normal to the axis of maximum compression, with S polarized parallel to the axis and S_1 polarized normal to it. By the time failure occurred, all seismic velocities had decreased by 12—30%. Amplitudes of the S_1 and P waves decreased by approximately 30%. A remarkable result of the experiment is that the amplitude of the S wave increased throughout the experiment until near failure. The amplitude at 90% failure strength was more than twice the value under hydrostatic pressure alone. These results are explained by analyzing how elastic moduli and energy dissipation due to frictional sliding at cracks are affected by anisotropic crack distribution developed in the sample as axial stress is applied.

GEOCHEMISTRY

REFER ALSO TO CITATION(S) 9733, 9735

OCEANOGRAPHY

11044 (DP—1455, pp 89-91) **Instrumented navigational light tower off the Savannah River estuary.** Hayes, D.W. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

An oceanographic and meteorological instrumentation system was installed on the Savannah Navigational Light Tower (November 1976). The instrumentation and recording system is providing synoptic information on ocean temperatures, currents, tides, salinity, and meteorological conditions. These data will aid in the interpretation of the processes governing pollutant transport in the Savannah River marine region and will support other ERDA-funded oceanographic programs in the southeastern United States.

11045 (DP—1455, pp 97) **Development of a physical oceanographic data set for the southeastern United States continental shelf.** Suich, J.E. (Savannah River Lab., Aiken, SC). May 1977.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1976.

The Savannah River Laboratory has surveyed appropriate federal and state agencies and academic institutions to locate sources of physical oceanographic data relevant to the continental shelf of the southeastern United States. About 55 reference documents containing tabular or graphical data were found; however, much of the data in these documents were not appropriate for a reference data base. By far the most comprehensive (but nonmachine readable) data set is that of the U.S. Coast Guard airborne radiation thermometer program. This data set yields sea-surface temperature to an accuracy of 1°C with good geographical coverage and a consistent time frame. However, the expense of digitizing several years of strip charts would be considerable, and could only be done at Coast Guard headquarters for security reasons. A series of FORTRAN computer programs were written to display the random geographic measurement locations and contours of sea-surface temperature observed by casual shipping vessels and archived at the National Climatological Center. Over a long period of record, spatial coverage of the oceans is quite dense at any point in time. However, specific coverage is sparse. The contours of sea-surface temperature are not readily displayed automatically owing to the considerable scatter of observed values with time and to the small sample size at any one time.

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

COSMIC RADIATION

REFER ALSO TO CITATION(S) 11086

COSMOLOGY

REFER ALSO TO CITATION(S) 11086

11046 **Views of the universe over cosmological time spans.** Lawrence, J.K. (Department of Physics and Astronomy, California State University at Northridge, Northridge, California 91324). *Am. J. Phys.;* **45**: No. 12, 1164-1167(Dec 1977).

We consider an Earth observer's view of the universe as it would appear at various stages of its evolution. This is calculated numerically from the relativistic Friedmann universe models and is presented in the form of Hubble plots of red shift versus distance for distant galaxies. Trajectories of particular galaxies followed through time are also shown. In the case of a closed universe, the results are particularly complex and interesting.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

BEAMS AND THEIR REACTIONS

REFER ALSO TO CITATION(S) 10678, 10679, 10701

11047 (CONF-770931—2) **Some analytical solutions to the two atom blocking model.** Oen, O.S. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 7p. Dep. NTIS, PC A02/MF A01.

From 7. international conference on atomic collisions in solids; Moscow, F.R. Germany (19 Sep 1977).

The two-atom blocking model with thermal displacements was reinvestigated, and some new analytical results were found. For Coulomb scattering, an exact solution for the blocking pattern is found which depends on only two parameters. For scattering from a Moliere potential, a similar parameterization produces a nearly universal set of curves. The results should be useful in analyzing data of ion backscattering experiments that measure crystal surface relaxation. 4 figures.

11048 **(e,2e) reactions in solids.** Avery, N.R. (Melbourne Univ., Parkville, Australia). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 195-203(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

The (e,2e) reaction on tungsten is studied. The results are still preliminary and thus far no coincidence events were detected. 6 references. (JFP)

11049 **High-current electron accelerator with rectangular cold cathode.** Akopov, R.A.; Antablyan, O.G. (Institute of Physical Studies, Academy of Sciences of the Armenian SSR, Ashtarak). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 4, 496-497(Apr 1977).

A high-current electron accelerator with a ribbon beam is developed for exciting a laser. The parameters of the accelerator are E=700 keV, I/sub e/=5.6 kA, and tau/sub p/=30 nsec. It is found experimentally that the best way to produce a beam of this shape is to use a cathode which is an elongated rectangle. For equal emitting areas, the currents from circular and rectangular cathodes are approximately equal.

11050 **Born approximation calculations of the Compton defect in aluminum.** Mendelsohn, L.B. (Brooklyn Coll.); Grossman, H. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 249-254(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

Excited state Hartree-Slater (EHS) calculations were performed on the systematics of Compton defects with increasing photon energy. For s states, the defects are typically negative and move toward zero with increasing momentum transfer. For p states the defects are typically positive. Thus both negative and positive defects for the entire atom are possible depending on the number of filled outer s and p orbitals and the experimental conditions. For the aluminum valence electrons, EHS calculations give a local maximum negative Compton defect of -2.5 eV. The experiment of R. Weiss gives a center of gravity Compton defect of -10 +- 7 eV .

11051 **High-energy ions from a Co_2 laser-produced plasma.** Ehler, A.W. (Univ of Calif, Los Alamos Sci Lab, NM). *J. Appl. Phys.;* **46**: No. 6, 2464-2467(Jun 1975).

A time-of-flight ion collector was used to measure the energy of ions from the plasma produced by a high-power CO_2 laser pulse focused on a flat polyethylene target. At laser irradiances exceeding $5x10^{12}$ W/cm^2 at the target, high-energy ion current spikes appeared in addition to the ion current from an expanding thermalized plasma. The measured arrival time of these spikes was consistent with the assumption that ions of different charge and mass were accelerated by a high potential during the laser pulse which was produced by a steep pressure gradient at the plasma surface. The accelerating potential was proportional to the laser irradiance at the target to the 2/3 power.

ATOMIC AND MOLECULAR PROPERTIES

REFER ALSO TO CITATION(S) 11061, 11211, 11364

11052 **Intense field multiphoton ionization via complex dressed states: Application to the H atom.** Chu, S.; Reinhardt, W.P. (Joint Institute for Laboratory Astrophysics, University of Colorado and National Bureau of Standards, Boulder, Colorado 80309). *Phys. Rev. Lett.;* **39**: No. 19, 1195-1198(7 Nov 1977).

Extension of Floquet theory to include continuum as well as bound atomic states yields a practical technique for computation of multiphoton ionization rates in the region where rms field strengths approach the strength of the internal atomic fields.

11053 **Two-electron photoionization of helium: Threshold law and energy spectrum of photoelectrons.** Yurev, M.S. *Opt. Spectrosc. (USSR) (Engl. Transl.);* **42**: No. 6, 594-596(Jun 1977).

The energy dependence of the two-electron photoionization cross section in the threshold region was investigated by the method of perturbation theory with respect to interelectron interaction. A nonlinear exponential threshold law $\sigma \sim E/sup\ 1.13/$ is obtained. It was demonstrated that there is an equally probable energy distribution of the photoelectrons near the threshold. When there is an increase in photon energy, one electron as a rule acquires almost all the photon energy. An analysis of the results of the present and other papers permits proposing an analytical expression for the function of the energy distribution of the photoelectrons which satisfactorily describes the energy spectrum over the entire dipole range.

11054 **Quasi-free (p,pα) scattering at 157 MeV.** Radvanyi, P. (Institut de Physique Nucleaire, Orsay, France). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 127(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

This is a short summary of results obtained in experiments performed with the Orsay Synchrocyclotron on the (p,pα) reaction on several even-even nuclei.

11055 **Green's function approach to the (hω,2e)-reactions.** Winkler, P. (Universitaet Erlangen-Nuernberg, Ger.). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 128-144(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

The main emphasis of this report is the recognition that the correlated motion of electrons is described only incompletely by the distribution of the one-electron momentum alone. This information must be supplemented by the distribution of relative momentum of the electrons in the system. It is believed that any kind of collective electron motion has its strongest and most direct impact upon this latter quantity. The ideas of an improved treatment are outlined for systems with two electrons outside of a closed shell. It is found that for those systems the problem can be formulated in a way which allows for an approximate inclusion of higher order contributions. Beryllium and negative lithium ions are considered. 37 references. (JFP)

COLLISION PHENOMENA

REFER ALSO TO CITATION(S) 11156

11056 (COO—2425-6) **Study of electron and uv photon surface interactions. Progress report, March 1, 1976—February 28, 1977.** Lichtman, D. (Wisconsin Univ., Milwaukee (USA)). Nov 1976. Contract EY-76-S-02-2425. 8p. Dep. NTIS $3.50.

Much additional data were obtained on electron stimulated desorption with the variable parameters of bombarding electron energy (0 to 6.5 keV), substrate material (304 stainless steel, platinum, niobium, etc.), substrate temperature (25 to 450°C) and desorbing species both ionic and neutral. Total cross sections for neutral desorption can be as high as 10^{-16} cm^2 and are generally 100 times as high as ionic desorption cross sections. Results are generally quite similar independent of the substrate material. Further theoretical analysis verifies the model for photodesorption presented last year. Preliminary results on graphite indicate similar photodesorption processes as observed are metal oxide semiconductors. CO_2 is again the dominant desorbing specie. Critical reviews on electron stimulated desorption and photodesorption have been completed. They are being distributed to interested parties. Preliminary measurements have been made using ion bombardment in the E.S.D. system in preparation for simultaneous ion and electron bombardment studies.

11057 (LBL—6662) **Semiclassical methods for nonseparable systems.** Garrett, B.C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1977. Contract W-7405-ENG-48. 194p. Dep. NTIS, PC A09/MF A01.

Thesis.

Semiclassical techniques have been widely used for describing the dynamics of molecular collisions. The calculation of discrete energy eigenvalue spectra in bound systems has also employed semiclassical methods. Work has been done toward developing semiclassical theories for rate constants in reactive systems and semiclassical eigenvalues in bound systems. Application of these theories have been made to nonseparable multidimensional systems. Transition-state theory has played an important role in chemical kinetics, and is very useful for approximating reaction rate constants for molecular systems. Many shortcomings of transition-state theory can be attributed to the assumption of separability of motion along the reaction coordinate. Semiclassical approximations have been

made to the quantum rate expression, and the resulting semiclassical theory has been applied to the reactive $H + H_2$ system. Comparison of this nonseparable theory with quantum scattering calculations shows agreement which is quite good. Although the quantum condition for one-dimensional bound systems is well-known, generalization of these results to multidimensional nonseparable systems is not obvious. Work has been done toward a semiclassical quantum condition which is closest to the approach of Born. The Hamilton—Jacobi equation for the systems is solved in action—angle variables; in this way the classical Hamiltonian can be expressed as a function of action variables which are constants of motion for the system. Requiring the action variables to be integers provides the semiclassical eigenvalues. Numerical calculations have been performed on a two-dimensional coupled potential well with good agreement with the quantum eigenvalues. 18 figures, 6 tables.

11058 Electron detachment from negative carbon and oxygen ions. Serenkov, I.T.; Il'in, R.N.; Oparin, V.A. (A. F. Ioffe Physico-technical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 4, 515-517(Apr 1977).

The cross sections for electron detachment from negative carbon ions in Mg, N_2, and CO and from negative oxygen ions in N_2 and CO are measured over the energy range 20—150 keV for the negative ions. The cross sections for electron detachment from negative carbon ions in the ground and excited states are distinguished on the basis of the decay of weakly bound states of the atomic particles in strong electric fields through the process $C^- + Mg \rightarrow C$. The cross sections for electron detachment from the C^- ions in the bound and excited states behave in different ways as functions of the velocity. The difference is interpreted as evidence for two different detachment mechanisms.

11059 Momentum determinations by knockout reactions. McCarthy, I.E. (Flinders Univ. of South Australia, Bedford Park). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 1-19(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

A knockout reaction is observed by a kinematically complete experiment in which two particles A and B emerge from the interaction region, one particle A being identical to the incident particle 0. The momenta of both are measured in coincidence. The separation energy epsilon of B and the recoil momentum q of the residual (core) system are both determined in the experiment. A theory is sought that fits the data in detail so that an accurate and sensitive probe can be found for the structure information. The (e,2e) reaction on argon and ethane are given as examples. Cross sections, orbital energy, distributions, and spectroscopic factors are found. (JFP)

11060 Determination of electronic momentum distributions and atomic and molecular structure using the (e,2e) reaction. Weigold, E. (Flinders Univ. of South Australia, Bedford Park). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 84-110(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

A survey of symmetric (e,2e) experimental results in atoms and molecules is presented. Information which can be extracted from such experiments using the off-shell impulse approximation is discussed. The noncoplanar symmetric geometry is particularly suited for obtaining structure information, whereas the coplanar arrangement is suited for studying distortion effects. Energy independent structure information is obtained on: shapes and magnitudes of electron momentum distributions in individual electron orbitals; separation energies for ion states with their orbital signature; spectroscopic factors describing the probability that an eigenstate contains the principal configuration of a hole in the characteristic orbital; and details of electron correlation effects in target states as well as final ionic states.

11061 Theoretical studies of the momentum distribution of molecular hydrogen. Smith, V.H. Jr. (Queen's Univ., Kingston, Ont.). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 145-150(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

The theoretical determination of the momentum distribution and Compton profile of H_2 ($X^1\Sigma g^+$) as a reference for experimental work is discussed with regard to the roles of electron correlation and molecular vibration.

11062 Investigation of (e,2e) knockout reactions via molecular electronic structure calculations. Williams, G.R.J. (Univ. of Sydney). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 151-168(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

Techniques are outlined that may be employed in molecular electronic structure calculations for the investigation of (e,2e) knockout reactions of molecules. One of these methods (the Green function technique) is used to illustrate how the momentum-space wave function for the water molecule may be computed.

11063 Validity of the (e,2e) reactions as a probe of the atomic and molecular structure. Giardini-Guidoni, A. (CNEN, Frascati, Italy) Tiribelli, R.; Vinciguerra, D.; Camilloni, R.; Stefani, G.; Missoni, G. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 205-226(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

Results of an extensive set of measurement of (e,2e) reactions on noble gases are reported, along with a concise description of the experimental set-up. Some conclusions are drawn on the conditions in which the (e,2e) reaction is a valuable tool to investigate atomic wave functions.

11064 Recent H.E.E.I.S. results on the Compton defect. Barlas, A.D.; Rueckner, W.; Wellenstein, H.F. (Brandeis Univ., Waltham, MA). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 241-248(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

Because helium is the simplest experimentally feasible system for which the Compton profile has been calculated to better than 0.1 percent precision at the maximum, the energy loss spectra of helium were studied to check the performance of this new apparatus, the method of data analysis, and the theory used to convert cross sections to Compton profiles. It soon became apparent that the energy loss spectra taken over a range of scattering angles do not reduce by means of the binary encounter theory (impulse approximation) to Compton profiles in agreement with theory. This disagreement is most evident in a shift of the experimental Compton peak from the peak predicted by the binary encounter theory. These results, as well as those obtained for molecular hydrogen, molecular deuterium, and molecular nitrogen are presented and discussed. The most important experimental parameters are summarized. (JFP)

11065 Compton defect: is there a shift in the Compton peak. McCarthy, I.E.; Bonham, R.A. (Indiana Univ., Bloomington). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 255-262(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

Recently observed shifs in the position of the maximum of Compton profiles using x-ray and HEEIS techniques and in the origin of momentum distributions using the (e,2e) reaction are discussed. The observed shifts for He from the free electron peak position are qualitatively explained by use of a distorted wave formalism. The problems remaining in the development of a quantitative theory for peak shifts are discussed.

ATOMIC AND MOLECULAR THEORY

REFER ALSO TO CITATION(S) 11170

11066 (CONF-770908—6) **Analysis of angular dependent Auger spectroscopy (ADAS) based on a quasiatomic model.** Davis, H.L. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 4p. Dep. NTIS, PC A02/MF A01.

From 7. international Vac. congress and 3. international conference on solid surfaces; Vienna, Austria (12 Sep 1977).

Calculated results are presented which are in good agreement with published M_2, $_3$VV Cu (100) ADAS data. The calculations are based on a quasiatomic model where each individual Auger emission is a partial wave of definite (l,m) character, but (l,m) may differ from emission to emission. The (l,m) emission weights have been estimated by fitting the data with a linear combination of calculated intensities for (l,m) up to $l = 5$. It is found that surprisingly few (l,m) values are necessary to obtain reasonable fits to the data, and the best fits occur for combinations of (l,m) intensities in which the $l = 3$ waves were most heavily weighted.

11067 Momentum wave functions, 1976. Devins, D.W. (ed.). New York; American Institute of Physics (1977). 284p. (CONF-760567—).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

The conference contained 23 papers, two of which appeared previously in ERA. Separate abstracts were prepared for 21 papers. (JFP)

GENERAL FLUID DYNAMICS

11068 Unstable normal mode for Rayleigh—Taylor instability in viscous fluids. Menikoff, R.; Mjolsness, R.C.; Sharp, D.H.; Zemach, C. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Fluids;* **20**: No. 12, 2000-2004(Dec 1977).

The character of the growth rates of the normal modes for Rayleigh—Taylor instability of superposed incompressible, viscous fluids is analyzed in terms of appropriately scaled dimensionless parameters and a particularly simple representation of the Rayleigh—Taylor dispersion relation. The chief feature that emerges is that the scaled growth rate is remarkably insensitive to the values of fluid densities and viscosities. To within a few percent, the physical growth rate depends only on the surface tension, the density-weighted average viscosity, and the effective acceleration. Approximate formulae for the most unstable wavenumber and the corresponding maximum growth rate are given.

PROPERTIES AND STRUCTURE OF FLUIDS

11069 (COO—2203-6) Polarized and depolarized light-scattering studies on Brownian diffusional and critical fluid systems: theory and experiment. Sorensen, C.M. (Colorado Univ., Boulder (USA). Dept. of Physics and Astrophysics). 1976. Contract EY-76-S-02-2203. 289p. Dep. NTIS, PC A13/MF A01.

Thesis.

An effort to expand light-scattering autocorrelation techniques to Brownian diffusional and critical fluid systems in which multiple scattering effects are important, and to understand the observed similarity of the Rayleigh linewidth of light scattered from these two seemingly different systems is discussed. A formalism was developed to find the light field multiply scattered from a suspension of Brownian diffusing particles. For the field doubly scattered from a system of noninteracting Brownian particles, the intensity and correlation time were much less dependent on the scattering angle than for the singly scattered component. The polarized and depolarized correlation times of light scattered from Brownian particle systems were measured. The double-scattering formalism was extended to light scattered from critical fluid systems. In the region k xi greater than 5 the doubly and singly scattered correlation times were nearly equal. The dynamic droplet model of critical phenomena was developed which gives the proper, experimentally verified, forms for the intensity and linewidth of light scattered from a critical fluid. To test the dynamic droplet model and the mode theories Rayleigh linewidth predictions, light-scattering measurements were performed on the critical fluid system methanol and cyclohexane. The data agreed with both the dynamic droplet and decoupled mode theory predictions. The depolarized scattered spectra from a critical fluid were measured, and qualitative agreement with the double-scattering theory was found. 57 figures, 5 tables.

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 10878

11070 Direct measurement of the π^- form factor. Dally, E.B.; Drickey, D.J.; Hauptman, J.M.; May, C.F.; Stork, D.H.; Poirier, J.A.; Rey, C.A.; Wojslaw, R.J.; Shepard, P.F.; Lennox, A.J.; Tompkins, J.C.; Toohig, T.E.; Wehmann, A.A.; Ioan, I.X.; Nigmanov, T.S.; Tsyganov, E.N.; Vodopianov, A.S. (Physics Department, University of California at Los Angeles, Los Angeles, California 90024). *Phys. Rev. Lett.;* **39**: No. 19, 1176-1179(7 Nov 1977).

We have measured the electromagnetic form factor of the charged pion by direct scattering of 100-GeV/c π^- from stationary electrons in a liquid-hydrogen target at Fermilab. The deviations from the pointlike pion-scattering cross section may be characterized by a root-mean-square charge radius for the pion of $< r^2/\text{sub } \pi/1/2 = 0.56 +- 0.04$ F.

WEAK INTERACTIONS

11071 Nucleon stability: a geochemical test independent of decay mode. Evans, J.C. Jr. (Brookhaven National Lab., Upton, NY); Steinberg, R.I. *Science;* **197**: No. 4307, 989-991(2 Sep 1977).

By analyzing published geochemical data on xenon isotopes measured in a 2.46 x 10^9-year-old telluride ore, a lower limit of 1.6 x 10^{25} years has been obtained for the mean lifetime of the nucleons in the tellurium-130 nucleus. This result is insensitive to the particular mode by which the nucleons decay and therefore provides a rigorous limit on possible baryon number nonconservation. The new limit is about two orders of magnitude better than the previous rigorous limit on nucleon stability.

11072 Possible experiments with very high energy cosmic neutrinos: the Dumand project. Berezinskii, V.S.; Zatsepin, G.T. (Institute of Nuclear Studies, USSR Academy of ciences). *Sov. Phys. - Usp. (Engl. Transl.);* **20**: No. 5, 361-380(May 1977).

A review is given of the experiments that can be performed using cosmic neutrinos in the TeV range. The physics of weak interactions is discussed with emphasis on the search for the W boson. Details are given of the Dumand, Athene, and unicorn experiments.(AIP)

STRONG BARYON-INDUCED INTERACTIONS

11073 Inclusive production of π^{+-}, K^{+-},p,p-bar in high-energy p-p collisions. Johnson, J.R.; Kammerud, R.; Ohsugi, T.; Ritchie, D.J.; Shafer, R.; Theriot, D.; Walker, J.K.; Taylor, F.E. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev. Lett.;* **39**: No. 19, 1173-1176(7 Nov 1977).

We have measured the single-particle inclusive cross sections for p + p → π^{+-} + X, Kπ^- + X, p + X, p-bar + X in the low-p/sub tr/region (9 or ≈ 1.5 GeV/c) as a function of the radial scaling variable X/sub R/ in p-p collisions at 100, 200, and 400 GeV at Fermilab. The measured π^+/π^- and K^+/K^- ratios are shown to be remarkably similar to the same ratios which have recently been measured at large p/sub tr/at 90° in the center-of-mass system.

11074 One-, two-, and three-particle distributions in pp collisions at 205 GeV/c. Kafka, T.; Engelmann, R.; Godbole, R.; Hanlon, J.; Pratap, M.; Wahl, H.; Singer, R.; Cho, Y.; Fields, T.; Hyman, L.G.; Voyvodic, L.; Walker, R.; Whitmore, J. (State University of New York, Stony Brook, New York 11794). *Phys. Rev., D;* **16**: No. 5, 1261-1293(1 Sep 1977).

Results of a Fermilab experiment using the 30- in. hydrogen bubble chamber are reported, with the main emphasis on pion production in the central region. Single-particle inclusive and semi-inclusive distributions in rapidity, Feynman x, and p/sub T//sup ts2/ for both π^- and π^+ are presented and compared with results of other experiments. Two-particle distributions are investigated using the correlation-function formalism. The relation between inclusive and semi- inclusive correlation functions is discussed. The semi-inclusive correlation functions in rapidity are found to have short-range character compatible with the ideas of independent-cluster- emission models. Evidence for effects due to Bose-Einstein statistics of like particle is found by comparing the joint correlation function in rapidity and azimuthal angle, as well as the charge multiplicity associated with transverse momentum in the like and unlike-charge combinations. Data on the average associated transverse momentum are also presented. The inclusive and semi-inclusive three-particle distributions are presented for all charge combinations. The inclusive three- particle correlations are found to be small for events with more than four particles in the final state. Two independent ways were found in which three-particle densities can be expresed in terms of one- two-particle densities.

11075 Structure of inclusive distribution in the longitudinal rapidity in the 20—200 GeV region. Azimov, S.A.; Lipin, V.D.; Olimov, K.; Usmanov, T.M.; Yuldashev, A.A.; Yuldashev, B.S. (Physico-technical Institute, Uzbek Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 9, 421-423(5 May 1977).

Equality of the normalized inclusive cross sections for the production of particles by hadrons on nucleons and nuclei is observed in the distribution in the longitudinal rapidity. The corresponding value of the rapidity increases like the logarithm of the primary-hadron energy.

STRONG MESON-INDUCED INTERACTIONS

11076 (LBL—6147) Polarized target experiment at Fermilab. Chamberlain, O. (California Univ., Davis (USA). Dept. of Engineering). Jan 1977. Contract W-7405-ENG-48. 18p. (CONF-770124—4). Dep. NTIS, PC A02/MF A01.

From Conference of the Orbis Scientiae Center for Theoretical Studies; Coral Gables, Florida, USA (16 Jan 1977).

Preliminary results are given for polarization measurements for π^+p and π^-p elastic scattering at 100 GeV. Results are not yet given for pp scattering also studied. It is noted that strictly speaking it is the asymmetry in the scattering off polarized protons that is measured. One relies on time-reversal invariance when this asymmetry is termed polarization. The values of the polarization are everywhere very small at this energy. These results appear to show no significant deviations from the predictions based on Regge theory and polarization measurements at lower beam energies. 2 references. (JFP)

11077 High-mass K* production in K^+d interactions at 9 GeV/c. Carmony, D.D.; Clopp, H.W.; Garfinkel, A.F.; Rangan, L.K.; Lander, R.L.; Pellett, D.E.; Yager, P.M.; Meiere, F.T.; Yen, W.L.

(Purdue University, West Lafayette, Indiana 47907). *Phys. Rev., D;* **16**: No. 5, 1251-1260(1 Sep 1977).

We have observed K* (1760) and K* (2100) production in a 10-event/μb K^+d experiment at 9 GeV/c. The K* (1760) has a mass of 1769 +- 12 MeV and a width of 132 +- 50 MeV and the K* (2100) has a mass of 2115 +- 46 MeV and a width of 300 +- 200 MeV. Branching ratios for decay into various final states are presented and evidence for decay into two, three, and four scalar mesons is presented. The spin-parity of the K* (1760) is found to be 3^-. The K* (2100) is compatible with a 4^+ assignment.

11078 Investigation of π^+Ne and π^-Ne interactions at 10.5 GeV/c. Yeager, W.M.; Walker, W.D.; Robertson, W.J.; Loos, J.S.; Lamsa, J.W.; Goshaw, A.T.; Fortney, L.R.; Elliott, J.R.; Sun, C.R.; Dhar, S. (Physics Department, Duke University, Durham, North Carolina 27706). *Phys. Rev., D;* **16**: No. 5, 1294-1317(1 Sep 1977).

Detailed studies of π^+Ne and π^-Ne interactions at 10.5 GeV/c have been carried out. Multiplicities, correlations, and inclusive momentum and rapidity spectra for π^+, π^-, π^0, and p are reported. Average multiplicities for K^0 and Λ^0 production are also determined. Comparisons are made to results from πp interactions. Relative to πp collisions, pion production is enhanced in the target-fragmentation region but not in the central or projectile-fragmentation regions. Many of the pion production properties can be understood in terms of a simple kinematical model in which the effective target mass is greater than a nucleon mass. A surprising number of energetic protons are observed (laboratory momentum > or ≈ 1.3 GeV/c). For shower-track multiplicities ~8, the produced nucleons are found to carry away an average of 40% of the incident momentum, indicating the possible existence of previously unrecognized mechanisms for the efficient momentum transfer to nucleons in particle-nucleus collisions.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

11079 (COO—1545-217) **Do fermion-pseudoparticle interactions generate quark masses.** Hietarinta, J.; Palmer, W.F.; Pinsky, S.S. (Ohio State Univ., Columbus (USA). Dept. of Physics). 1977. Contract EY-76-C-02-1545. 8p. Dep. NTIS, PC A02/MF A01.

It is shown that pseudoparticle solutions with integer winding number do not generate mass terms or breaking of chiral SU(N) in theories with a nontrivial flavor group.

11080 Structure of the Pomeron. Dean, N.W. (Department of Physics, Iowa State University, Ames, Iowa 50011). *Phys. Rev., D;* **16**: No. 5, 1348-1353(1 Sep 1977).

At t = 0, the Pomeron-pole-plus-cuts series is shown to be a simple power series in the variable v = (s/is$_0$)/sup alpha0-1//ln(s/is$_0$), where α_0 is the pole intercept. If $\alpha_0 > 1$, the series moves outside its circle of convergence as s → ∞. Appropriate analytic continuation allows the series to saturate the Froissart bound. For 7.5 9 or ≈ √s 9 or ≈ 53 GeV, v is almost constant, explaining the near-constancy of total cross sections. Excellent fits are obtained to the data for any function of v with the right value and slope. These fits indicate that the dominant contributions come from the PP and PPP cuts rather than the pole term. An extension to t not = 0 yeilds an intriguing relation between the impact-parameter amplitude and the energy dependence of the forward amplitude.

ELECTROMAGNETIC INTERACTIONS

11081 Charmed meson production in electron-positron annihilation. Humpert, B.; Clark, R.B. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **16**: No. 5, 1327-1333(1 Sep 1977).

Charmed-meson production is analyzed in a free-quark model. Arguments are given for the predominance of electromagnetic c-quark pair creation with subsequent q-quark association. F-meson production is not suppressed. Experimental tests of these findings are suggested in regions with and without resonances.

11082 Muon-number-nonconservation effects in a gauge theory with V + A currents and heavy neutral leptons. Cheng, T.; Li, L. (Physics Department, University of Missouri: St. Louis, St. Louis, Missouri 63121). *Phys. Rev., D;* **16**: No. 5, 1425-1443(1 Sep 1977).

Since gauge theories eigenstates of weak interactions are in general not mass eigenstates, we would not expect flavor conservation. In particular this should also hold for the leptonic flavors: muon numbers and electron numbers, etc. The apparent conservation of muon number in the standard V - A theory should be interpreted as reflecting the fact that neutrino masses (if not identically zero) are almost degenerate when viewed on the normal mass scale. In theories containing V + A currents, the right-handed muon and electrons are expected to couple to intermixing heavy leptons in the GeV range. In such theories muon-number-violation effects will be dramatically larger. However, when constructing new models of leptons one should be mindful that flavor-changing neutral-current processes such as μ → eγ and μ → eee-bar are suppressed experimentally. This indicates the need for a "leptonic Glashow-Iliopoulos-Maiani cancellation mechanism." We have proposed a way to incorporate these features in an SU_2 x U_1 gauge theory. Basically it involves the addition to the standard Weinberg-Salam theory right-handed doublets with the electron and muon coupled to orthogonal "heavy neutrinos." This leads to an electronic neutral current which is purely vector and its attendant suppression of parity-violation effects in high-Z atoms. Muon-number-nonconservation effects involving only familiar particles are higher-order weak processes and are naturally of the order G/sub F/^{2}. In this paper we give details of our calculations of μ → eγ, μ → eee-bar, K/sub L/ → emu-bar, K → πeμ, and μe conversion in a nucleus, etc. In order to have a "natural" theory, we have incorporated recent suggestions made by Bjorken, Lane, and Weinberg about the Higgs structure for such a model. This modification increases the rate for μ → eγ by a factor of 25 but does not materially affect other processes. For a heavy-lepton mass-difference and mixing-angle combination of sinphi cosphi[m

11083 Decay μ → eγ in models with neutral heavy leptons. Bjorken, J.D.; Lane, K.; Weinberg, S. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **16**: No. 5, 1474-1483(1 Sep 1977).

We explore possible muon-number-nonconserving processes in gauge theoreis in which the right-handed muon and electron appear along with neutral heavy leptons in SU(2) x U(1) doublets. The same mechanism which gives a mass to the electron and muon is expected to mix the left-handed neutral leptons with the neutrinos. In the simplest case, this leads to a rate for μ → eγ 25 times larger than previously calculated in such models. Other phenomenological consequences of these theories are discussed. Formulas are given for the magnetic dipole transition matrix element in general gauge theories, and these are used to derive general conditions for suppression of μ → eγ to acceptable levels.

11084 Has a Higgs particle been seen. Ma, E.; Pakvasa, S.; Tuan, S.F. (Department of Physics and Astronomy, University of Hawaii at Manoa, Honolulu, Hawaii 96822). *Phys. Rev., D;* **16**: No. 5, 1568-1570(1 Sep 1977).

Many Higgs doublets have been proposed recently in connection with CP and muon-number nonconservation. We ask here whether some of these may be especially interesting, perhaps even offering an explanation of the anomalous eμ events seen in e^+e^- annihilation for √s > or ≈ 4 GeV. A model is discussed together with the general phenomenology and predictions associated with such a possibility.

11085 Are hydrodynamic models of high-energy collisions credible. Moravcsik, M.J.; Teper, M. (Department of Physics and Institute of Theoretical Science, of Oregon, Eugene, Oregon 97403). *Phys. Rev., D;* **16**: No. 5, 1593-1595(1 Sep 1977).

The foundations of hydrodynamics models for high-energy collisions are questioned by pointing out the most of the energy in such collisions must be radiated off in electromagnetic and strong bremsstrahlung before the equilibrium initial conditions assumed in hydrodyamic models could be established.

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 11082

11086 (ORO—3992-313) **Cosmological implications of massive, unstable neutrinos.** Dicus, D.A.; Kolb, E.W.; Teplitz, V.L. (Texas Univ., Austin (USA). Center for Particle Theory; Virginia Polytechnic Inst., Blacksburg (USA). Dept. of Physics). Jun 1977. Contract EY-76-S-05-3992. 42p. Dep. NTIS, PC A03/MF A01.

The lifetime needed for heavy neutrino decay ν/sub H/ → ν/sub e/ + γ to create a sufficient background of energetic ν/sub e/ and γ to solve the missing cosmological mass problem is calculated. As a function of its mass the effects of ν/sub H/ decay on the cosmic x-ray background, on the Davis solar neutrino experiment, and on the cosmic helium abundance are also computed in some detail. Considerations, with some additional hypotheses, lead to the prediction of a heavy neutrino in the MeV range associated with the charged, GeV range, leptons that were discussed and possibly detected over the past few years.

11087 Nonscaling behavior: The proton, neutron, and deuteron structure functions. Schmidt, I.A.; Blankenbecler, R. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **16**: No. 5, 1318-1326(1 Sep 1977).

We present a simple parton-model interpretation of the approach to scaling observed in lepton scattering off protons and deuterons. Different final-state configurations are classified and their behavior predicted using quark-counting rules. Good fits to the

proton data are obtained. Using a relativistic description of the deuteron, its elastic form factor and inelastic structure function are analyzed. An extraction of the neutron structure function is performed by fitting the deuteron data. Several characteristics of the resulting parametrizations are shown to support our general model. Further experimental consequences are described.

11088 Natural suppression of symmetry violation in gauge theories: Muon- and electron-lepton-number nonconservation. Lee, B.W.; Shrock, R.E. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **16**: No. 5, 1444-1473(1 Sep 1977).

We analyze the circumstances under which the violations of an approximate symmetry in a unified gauge theory of weak interactions are naturally suppressed; in particular, we investigate approximate muon- and electron-type lepton-number conservation as an example of such a symmetry. Extending earlier work, we propose a unified treatment of this symmetry together with strangeness conservation by the weak neutral current and CP invariance. The rate for the decay $\mu \rightarrow e\gamma$ is calculated for a general SU(2) x U(1) gauge model. From this and a similar study of the decay $\mu \rightarrow$ eee-bar we derive a set of conditions which guarantees that the violation of muon- and electron-type lepton-number conservation is naturally strongly suppressed. As part of this, we compute the nondiagonal electromagnetic vertex to one-loop order for an arbitrary SU(2) x U(1) gauge theory. We then focus on the phenomenological predictions of a particular gauge model with three left-handed doublets of leptons and quarks. These include the existence of charged and neutral heavy leptons and of small violations of μ-e universality and the relation G/sub F//sup β/C-italic = G/sub F//sup μ/Other muon- and electron-number-violating effects include nonvanishing rates for the decays K^{+-} +- emu-bar and K/sub L/ $\rightarrow$ emu-bar, and for the reactions $\mu + N \rightarrow e + N$ and ν/sub μ//sub ts[tsN tsarrow-righttse-/ + X.

11089 Hadronic decays of eta/sub c/. Quigg, C.; Rosner, J.L. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **16**: No. 5, 1497-1504(1 Sep 1977).

Hadronic branching fractions for the pseudoscalar psions are predicted on the basis of a simple model for psi (3095) decays. Results are given for hypothetical states at 2830, 3095, and 3455 MeV/c^2. Particular emphasis is placed on modes which may be observed as one-constraint final states in e^+e^- annihilation into hadrons and on channels in which backgrounds are expected to be low.

11090 Bound-state spectroscopy of superheavy quarks. Fernandez-Pacheco, A.; Grifols, J.A. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **16**: No. 5, 1510-1512(1 Sep 1977).

The transition to the exact positronium spectrum is studied as a function of quark mass. It is shown that, in the nonrelativistic potential approach, only for quarks as heavy as ~100 GeV might one expect to see the level structure originally attributed to charmonium. It is also noted that in the hypothetical case that superheavy quarks exist one may directly produce via the weak current their 1^{++} bound states in future e^+e^- experiments.

11091 Weak interactions at very high energies: The role of the Higgs-boson mass. Lee, B.W.; Quigg, C.; Thacker, H.B. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **16**: No. 5, 1519-1531(1 Sep 1977).

We give an S-matrix-theoretic demonstration that if the Higgs-boson mass exceeds M/sub c/ = $(8\pi\sqrt{2}/3G$/sub F/)/sup 1/2/, parital-wave unitarity is not respected by the tree diagrams for two-body scattering of gauge bosons, and the weak interactions must become strong at high energies. We exhibit the relation of this bound to the structure of the Higgs-Goldstone Lagrangian, and speculate on the consequences of strongly coupled Higgs-Goldstone systems. Prospects for the observation of massive Higgs scalars are noted.

11092 Comments on a V - A theory of muon-number nonconservation. Cheng, T.; Li, L. (Department of Physics, University of Missouri: St. Louis, St. Louis, Missouri 63121). *Phys. Rev., D;* **16**: No. 5, 1565-1567(1 Sep 1977).

We report the results of our calculations on $\mu \rightarrow$ eee-bar, K/sub L/ $\rightarrow$ emu-bar in a gauge theory with three left-handed lepton doublets, which as been proposed recently by other authors in connection with muon-number nonconservation. Other remarks about this model are also included.

STRONG INTERACTIONS, GENERAL

11093 Whirlpools in the sea: Polarization of antiquarks in a spinning proton. Close, F.E.; Sivers, D. (Rutherford Laboratory Chilton Didcot, Oxfordshire OX11 0QX, England, and Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **39**: No. 18, 1116-1120(31 Oct 1977).

We argue that the sea of virtual quark-antiquark pairs in a proton is polarized. Quantum chromodynamics allows a valence quark to emit a gluon which then produces pairs. If the parent quark in this process exhibits a $(1-x)^3$ behavior as $x \rightarrow 1$ then the antiquark with helicity the same as the original quark will have a leading $(1-x)^5$ distribution. Implications for the counting rules and for polarized Drell-Yan annihilation are discussed.

11094 Large P/sub T/ physics: Data and constituent models. Ellis, S.D.; Stroynowski, R. (Department of Physics, University of Washington, Seattle, Washington 98195). *Rev. Mod. Phys.;* **49**: No. 4, 753-775(Oct 1977).

Recent developments in the field of large p/sub T/ physics are reviewed. Special attention is paid to the explanation of the data offered by specific constituent models. Emphasis is placed on those data which tend to differentiate between the models. Prospects for better understanding of large p/sub T/ events as the result of new experiments and further theoretical work are discussed.

11095 Interaction of isovector scalar mesons with simple sources. Bolsterli, M. (T Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., D;* **16**: No. 6, 1749-1753(15 Sep 1977).

A variational procedure using coherent states is shown to be superior to previous methods for treating the interaction of charged or isovector mesons with a static source. The technique is then applied to interaction with a Schroedinger field.

11096 Quark elastic scattering in gauge theories and large-transverse-momentum hadron production. Duke, D.W. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **16**: No. 5, 1375-1388(1 Sep 1977).

Quark elastic scattering in a color gauge theory of quarks and gluons is investigated as a source of large-transverse-momentum hadrons. Nonscaling effects due to asymptotic freedom alone are not helpful in describing the data. Elastic quark-quark form factors derived in color gauge theories do describe the data if supplemented by a phenomenological assumption which probably amounts to antiscreening of the color of quarks in a proton. Transverse-momentum fluctuations of quarks in protons are quite important for understanding the normalization and shape of the theory. Patterns of scaling violations are predicted which may be compared with good future data to test the models.

11097 Flavor-changing neutral-current processes in gauge models and strong interactions. Hagiwara, T. (The Rockefeller University, New York, New York 10021). *Phys. Rev., D;* **16**: No. 5, 1532-1534(1 Sep 1977).

The effect of strong interactions on flavor-changing neutral-current (FCNC) processes is discussed. In order that the FCNC semileptonic process I $\rightarrow$ F + ν + nu-bar does not take place to order G/sub F/ nor to order G/sub F/α, the hadronic matrix elements of weak-interaction currents must satisfy (A) <FJ^0/sub μ//sub I/to first order in the gauge coupling and (B) F/sup F I//sub munu tstsintegrald4/x e/sup -i k x/<F T (J^+/sub μ//sub(x)/J^-/sub ν//sub())I> ~O (k^{-2}) O/sup F I//sub munu/as k = $[k^2 + (ik_0)^2]$/sup 1/2/ $\rightarrow \infty$, where I and F are hadronic states of different flavors and J^0/sub μ/and J^{+-} μ are neutral and charged weak-interaction currents, respectively, while O/sup F I//sub munu/stands for the matrix elements of finite operators. By examining conditions (A) and (B), we show that if the FCNC quark process q/sup I/ $\rightarrow$ q/sup F/ + ν + nu-bar is suppressed to order G/sub F/ and to order G/sub F/α, the semileptonic process I $\rightarrow$ F + ν + nu-bar is also suppressed to the same order, where the q/sup I//sup(F)/ quark carries the same flavor as the hadronic state I (F).

11098 High-energy hadron dynamics based on a stochastic-field multieikonal theory. Arnold, R.C. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **16**: No. 5, 1545-1564(1 Sep 1977).

Multieikonal theory, using a stochastic-field representation for collective long-range rapidity correlations, is developed and applied to the calculation of Regge-pole parameters, high-transverse-momentum enhancements, and fluctuation patterns in rapidity densities. If a short-range-order model, such as the one-dimensional planar bootstrap, with only leading t-channel meson poles, is utilized as input to the multieikonal method, the pole spectrum is modified in three ways: promotion and renormalization of leading trajectories (suggesting an effective Pomeron above unity at intermediate energies), and a proliferation of dynamical secondary trajectories, reminiscent of dual models. When transverse dimensions are included, the collective effects produce a growth with energy of large-P/sub T/ inclusive cross sections. Typical-event rapidity distributions, at energies of a few TeV, can be estimated by suitable approximations; the fluctuations give rise to "domain" patterns, which have the appearance of clusters separated by rapidity gaps. The relations between this approach to strong-interaction dynamics and a possible unification of weak, electromagnetic, and strong interactions are outlined.

11099 Mechanisms of multi-particle production processes. Andreev, I.V.; Dremin, I.M. (P. N. Lebedev Physics Institute, USSR Academ of Sciences). *Sov. Phys. - Usp. (Engl. Transl.);* **20**: No. 5, 381-405(May 1977).

A review is given of various proposed models of multiple production interactions. Among the models discussed are the quark model, multiperipheral model, regge model, and statistical model.(AIP)

STRONG INTERACTIONS, BARYON NO.=0

11100 Estimates of production cross sections and distributions for W bosons and hadronic jets in high-energy pp and p anti p collisions. Peierls, R.F.; Trueman, T.L.; Wang, L. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., D;* **16**: No. 5, 1397-1421(1 Sep 1977).

Using the quark-parton model, with structure functions chosen to agree with electroproduction and lepton-pair-production data, the cross sections are calculated for the production of charged and neutral W mesons in high-energy pp collisions. The single- and double-particle distributions for the leptonic and hadronic decays of the W are presented along with leptonic background from electromagnetic pair production. Using the same model, the cross sections for production of single and double hadronic jets are also calculated using both color-vector-gluon exchange and the Field-Feynman models for the elementary quark-quark scattering. It is concluded that the leptonic decay of the W should be a strong signal well above background, and that the parity violation of the weak interaction leads to characteristically different distributions for leptons and antileptons. The production in proton-antiproton collisions is also studied and found to be only slightly above the proton-proton production. The cross section does not incease rapidly with energy for s/m/sub W/^{2} > or ≃ 10. For hadronic jet production, the vector-gluon and Field-Feynman models lead to significantly different distributions, and if the predictions of the former are true the hadronic jet decay of the W, although plentiful, will be difficult to see above background. The effects of transverse motion of the W, neglected in the quark model, are found to be unimportant.

11101 Lepton-pair production and the modified Drell-Yan mechanism in high-energy unpolarized and polarized pp and p anti p collisions. Chen, C.K. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **16**: No. 5, 1576-1579(1 Sep 1977).

A modified Drell-Yan mechanism for inclusive dilepton pair production in hadronic reactions is studied, and the significance of comparing high-energy unpolarized and polarized pp and p anti p collisions is discussed. The required beams are currently proposed at Fermilab and CERN.

STRONG INTERACTIONS, BARYON NO.=1

11102 Low-energy pion-nucleon scattering. Banerjee, M.K.; Cammarata, J.B. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Rev., D;* **16**: No. 5, 1334-1338(1 Sep 1977).

Using the divergence of the axial-vector current as the pion interpolating field and a soft-pion limit we derive a once-subtracted Low equation for the off-mass-shell πN amplitude. The σ commutator term and the once-subtracted z graphs are the main isoscalar and isovector driving terms. The calculated S-wave phase shifts are in good agreement with the experimental data when we use vertical-barg/sub π//sub(4M2/) vertical-bar = 11.69 and 25.5 MeV for the σ commutator term.

11103 Effective-gluon model description of inclusive meson production in π^{+-} p and pp collisions. Look, G.W.; Fischbach, E. (Physics Department, Purdue University, West Lafayette, Indiana 47907). *Phys. Rev., D;* **16**: No. 5, 1369-1374(1 Sep 1977).

The recently introduced effective-gluon (EG) model is applied to inclusive meson production at large transverse momentum (p/sub t)/from π^{+-}p and pp interactions. In the EG model the dependence of the inclusive differential cross section on p/ sub t/ and center-of-momentum energy $\sqrt{s}$ is characterized by a single universal constant B = 18 GeV^2; this constant is obtained by fitting to the inclusive data for pp → cX with c = π^{+-} π^0, K^{+-} p, and p-bar. Since the EG model requires that the inclusive differential cross sections for π^{+-}p → X/should be characterized by the same constant B, the dependence of these cross sections on p/sub t/and $\sqrt{s}$ should follow from the previous analysis of pp → cX without the introduction of any additional parameters. The only new information required is the form of the momentum distribution function for partons in the incident pion. Several models for this function are considered and it it shown that all of the alternatives lead to approximately the same predictions. Comparison of theory and experiment indicates that the EG model description of the recent Fermilab data of Donaldson et al. is good to approximately 15—20 % per data point over a range of more than 10^5 in the magnitude of the inclusive cross section.

11104 Comparison of recent high-p/sub tr/data with the effective-gluon model. Fischbach, E.; Look, G.W. (Physics Department, Purdue University, West Lafayette, Indiana 47907). *Phys. Rev., D;* **16**: No. 5, 1571-1575(1 Sep 1977).

The effective-gluon (EG) model of high-p/sub t/inclusive scattering is compared to recently published Fermilab data. The EG model is shown to describe accurately the observed features of the data for the production of π^0, π^{+-} K^{+-} p, and p-bar. Features of the model which are independent of the exact nature of the quark distribution and decay functions are discussed.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

11105 Hadron production in nuclear collisions—a new parton-model approach. Brodsky, S.J.; Gunion, J.F.; Kuehn, J.H. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **39**: No. 18, 1120-1123(31 Oct 1977).

We consider a quark-parton model in which wee partons of the projectile interact with wee partons of essentially independent nucleons in the nuclear target. The ratio of multiplicities in the central region is < n >/sub H A// < n > /sub H N/ = 1/2ν + ν(ν + 1), where ν is the mean number of inelastic collisions of the projectile H, in agreement with experiment. We also predict nucleus-nucleus multiplicities, the multiplicity distribution, and the absence of shadowing in large-q^2 and large-p/sub T/ reactions.

11106 Model for massive-lepton-pair production. Duong-van, M.; Vasavada, K.V.; Blankenbecler, R. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **16**: No. 5, 1389-1396(1 Sep 1977).

A general model for the production of massive lepton pairs is discussed with emphasis on the predicted distributions of mass, transverse momentum, and longitudinal momentum. A comparison with proton-proton experiments is given and the fit is satisfactory for all three distributions. The model is essentially the constituent-interchange-model approach to large-transverse-momentum reactions and no new parameters are needed. In a specific kinematic limit, it predicts the same mass distribution as the Drell-Yan model, a broad power-behaved transverse-momentum distribution, and allows two independent ways of normalizing the rate.

11107 Short-range part of the nuclear force. Liberman, D.A. (Los Alamos Scientific Laboratory, Theoretical Division, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., D;* **16**: No. 5, 1542-1544(1 Sep 1977).

A simple form of the quark theory accounts for the strong short-range repulsion between nucleons and makes it possible to estimate the magnitude of this part of the nuclear force.

11108 Factorizability hypothesis in the quark model and large-angle elastic scattering of hadrons. Pashkov, A.F.; Skachkov, N.B.; Solovtsov, I.L. (Joint Institute for Nuclear Research). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 9, 423-426(5 May 1977).

The model of factoring quarks is supplemented by a dynamic hypothesis concerning the form of the scattering of a quark by a self-consistent potential. A simple formula, including a dependence on the number of the component quarks, is obtained for the hadron cross sections in the asymptotic form. A comparison is made with the experimental data on pp scattering.

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

GENERAL

11109 Properties of axial-vector-current divergences in the constituent-quark basis. Fuchs, N.H. (Institut de Physique Nucleaire, Division de Physique Theorique, 91406 Orsay Cedex, France). *Phys. Rev., D;* **16**: No. 5, 1535-1541(1 Sep 1977).

The properties of the axial-vector currents and their divergences are examined in the context of the quark model as quantized on the null plane. The SU(3) transformation properties of the divergences are not as they naively appear to be. It is found that correction terms to strong PCAC (partial conservation of axial-vector current) are expected, especially for kaons, and that these terms are likely to be proportional to one-body quark operators (and therefore octet operators), but that the proportionality constants may have a mixture of linear and quadratic dependence on the quark mass parameters. In view of this, some consequences of the one-body nature of the PCAC-correction terms are derived without making any assumptions of SU(3) algebraic structure. A universality relation which was recently obtained by Dominquez is a direct result of this line of reasoning; furthermore, assuming the pion PCAC correction Δ/sub π/is small, a value for Δ/sub K/ of approximately 0.2 follows. This then is used to correct some old PCAC formulas, bringing them into agreement with experiment. Finally, the consequences of some

assumptions concerning the SU(3) properties of the axial divergences are explored.

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

11110 Quark-loop dominance in the SU(3) σ model. Chan, L. (Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803). *Phys. Rev. Lett.;* **39**: No. 18, 1124-1127(31 Oct 1977).

This work examines the quark-loop contributions in the renormalizable SU(3) σ model. Radiative meson-decay rates are found to be in good agreement with experiments. The quark-loop contribution is shown to dominate the vector form factor and, in the Pade approximation, the vector form factor exhibits the picture of vector dominance. To this order of approximation, the closeness between the calculated and the known values of m/sub rho/m/sub ω/m/sub phi/and Γ/sub rho/provides further evidence that quarks have three colors.

11111 P and CP nonconservation through Higgs exchange in gauge models with right-handed charged currents. Deshpande, N.G.; Ma, E. (Institute of Theoretical Science, University of Oregon, Eugene, Oregon 97403). *Phys. Rev., D;* **16**: No. 5, 1513-1518(1 Sep 1977).

The recent proposal of Weinberg that CP violation occurs through the exchange of charged Higgs bosons is examined in detail for gauge models with right-handed charged currents. We find that parity must be violated as well through the exchange of neutral Higgs bosons. In a five-quark model, this effect could be considerably bigger than that of the usual weak interaction, and should be looked for in psi' $\rightarrow$ psi$\pi\pi$ and psi' $\rightarrow$ psiπ^0 as a test of this whole theoretical framework. Other interesting phenomena are the enhanced production of certain Higgs bosons and a value for the neutron electric dipole moment which is within experimental limits.

11112 Comment on Weinberg's gauge theory of CP nonconservation. Deshpande, N.G.; Ma, E. (Institute of Theoretical Science, University of Oregon, Eugene, Oregon 97403). *Phys. Rev., D;* **16**: No. 5, 1583-1585(1 Sep 1977).

We show that if CP violation occurs through the exchange of charged Higgs bosons as recently proposed by Weinberg, then P (and hence CP) is also violated through the exchange of neutral Higgs bosons. Whereas K/sub L/ $\rightarrow 2\pi$ is not affected by this additional interaction, the neutron electric dipole moment is, and its value can be well within experimental limits.

FIELD THEORY

REFER ALSO TO CITATION(S) 11088

11113 Local operator products in gauge theories. I. Joglekar, S.D. (The Institute for Advanced Study, Princeton, New Jersey 08540). *Ann. Phys. (N.Y.);* **108**: No. 2, 233-287(Oct 1977).

The renormalization and gauge invariance of products of local gauge-invariant operators and their operator product expansions in gauge theories are discussed in detail. The problem studied leads to the complete understanding of the operator product expansion of a product of two gauge-invariant operators. The problem is to consider the complete set of color singlet local functionals of gauge, matter, and ghost fields (F[A, c, c-bar, eta$_0$]) in a non-Abelian unbroken gauge theory of strong interactions containing fermions and find what subset of these local operators have the property that all of their "physical matrix elements" are eta-independent to all orders in the perturbation theory. (Note: All the phrases in quotes and the above statement are to be defined in the text by certain limiting procedures whereupon they become precise mathematical statements.) Here, eta is a gauge parameter. We believe that the discussion given here can be extended to spontaneously broken gauge theories in a straightforward manner, where of course, the physical matrix elements exist in perturbation theory. The conclusion is that the only nontrivial operators that have this property to all orders are all the gauge-invariant operators and certain gauge variant operators which are a subset of the renormalization counterterms a gauge-invariant operator at zero momentum needs. However, these gauge-variant operators are not new physical entities in the sense that their "renormalized physical matrix elements" are not independent to the "S-matrix elements." These results will be useful in understanding which operators appear in the operator product expansion of, say two currents, letting one use these methods with full understanding in gauge theories. As a by-product, certain technical discussions in this paper can be used to considerably shorten the proof of a theorem in the renormalization of gauge-invariant operators previously given.

11114 Stress tensors and their trace anomalies in conformally flat space-time. Brown, L.S.; Cassidy, J.P. (Department of Physics, University of Washington, Seattle, Washington 98195). *Phys. Rev., D;* **16**: No. 6, 1712-1716(15 Sep 1977).

Stress-energy tensors of massless fields propagating in curved space-times which are conformally flat are determined entirely from their trace anomalies. This calculation utilizes the integrability condition obeyed by stress tensors for arbitrary variations of the metric and sheds some light on the nature of the dimensionally continued renormalization method.

11115 Classical null strings. Schild, A. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **16**: No. 6, 1722-1726(15 Sep 1977).

Free Nambu strings in space-time are the two-dimensional sheet analog of one-dimensional curves which are timelike or spacelike geodesics. It is pointed out that there is also a sheet analog of one-dimensional curves which are null geodesics.

11116 Spinor Yang-Mills superfields. Gates, S.J. Jr. (Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **16**: No. 6, 1727-1732(15 Sep 1977).

Following the example provided by the ordinary derivative and vector Yang-Mills fields, we give an argument which demonstrates that spinor superfields may be combined with the fermionic components of the invariant superspace gradient in order to define a fermionic, supersymmetric Yang-Mills covariant derivative. Additionally, it is shown that this fermionic, covariant gradient is the "square root" of a bosonic covariant gradient. Thus, it is possible to define a "supercovariant derivative" is superspace. We also discuss some general aspects of supersymmetric, Yang-Mills theories.

11117 Evaluation of effective potential in superspace. Huq, M. (Center for Particle Theory, Department of Physics, The University of Texas, Austin, Texas 78712). *Phys. Rev., D;* **16**: No. 6, 1733-1739(15 Sep 1977).

We show that it is possible to calculate the effective potential in superspace without decomposing superfields into component fields. The most general renormalizable Lagrangian for chiral superfields is treated.

11118 Borel summability and the renormalization group. Khuri, N.N. (Rockefeller University, New York, New York 10021). *Phys. Rev., D;* **16**: No. 6, 1754-1761(15 Sep 1977).

The assumptions and results of recent work by Lipatov and others on the behavior of perturbation theory at high orders are delineated and used in conjunction with the Callan-Symanzik equation. Some consequences related to Borel summability and scaling are obtained for gphi^4 field theory in four dimensions. Our main result is to show that the above work implies that for this theory a contradiction exists between Borel summability in which the Borel sum fully determines the Euclidean Green's functions in a fixed interval, $0 < g < \epsilon$, and the existence of a nontrivial ultraviolet-stable fixed point for $0 < g < \infty$.

11119 Quantum field theories on a lattice: Variational methods for arbitrary coupling strengths and the Ising model in a transverse magnetic field. Drell, S.D.; Weinstein, M.; Yankielowicz, S. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **16**: No. 6, 1769-1781(15 Sep 1977).

This paper continues our studies of quantum field theories on a lattice. We develop techniques for computing the low-lying spectrum of a lattice Hamiltonian using a variational approach, without recourse either to weak- or strong-coupling expansions. Our variational methods, which are relatively simple and straightforward, are applied to the Ising model in a transverse magnetic field as well as to a free spinless field theory. We demonstrate their accuracy in the vicinity of a phase transition for the Ising model by comparing with known exact solutions.

11120 Effect of fermions upon tunneling in a one-dimensional system. Gildener, E.; Patrascioiu, A. (Department of Physics, B-019, University of California, San Diego, La Jolla, California 92093). *Phys. Rev., D;* **16**: No. 6, 1802-1805(15 Sep 1977).

We study the effects of a fermion with Yukawa-type coupling upon the tunneling of the double-well anharmonic oscillator. These effects prove to be nondramatic, despite the zero-frequency bound-state eigenmode one would encounter if one applied the conventional boundary conditions to the path integral.

11121 Lorentz transformations for gauge-theory monopole solutions. Sinha, A. (Department of Physics, Columbia University, New York, New York 10027). *Phys. Rev., D;* **16**: No. 6, 1828-1835(15 Sep 1977).

We discuss the Poincare group transformations in the presence of monopole solutions in gauge theories, using the canonical formalism developed by Christ, Guth, and Weinberg. We show that the infinitesimal transformations generated by the Dirac brackets with the generators defined, as usual, by the Belinfante tensor satisfy the Poincare group algebra, in the so-called axial gauge II.

11122 Virial theorem and stability of localized solutions of relativistic classical interacting fields. Rafelski, J. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **16**: No. 6, 1890-1899(15 Sep 1977).

The properties of classical meson fields interacting with the Dirac field are considered in more detail analytically. We obtain a virial relation between the kinematic and potential energy of the interacting Dirac field. The stability of the classical solutions of the coupled fields constrained to the lowest particle solution of the Dirac equation in three space dimensions is investigated. A criterion allowing the determination of stability of Abelian meson fields in interaction with the Dirac field is given.

11123 Exact two-particle S matrix of quantum solitons of the sine-Gordon model. Zamolodchikov, A.B. (Institute of Theoretical and Experimental Physics). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 10, 468-471(20 May 1977).

Exact and explicit formulas are constructed for the S-matrix elements of soliton-antisoliton scattering. These formulas agree with the perturbation theory of the Thirring massive model and with the quasiclassical expressions.

PHYSICS RESEARCH (CONT.)

NUCLEAR PHYSICS

11124 (CERN—76-13) **3rd international conference on nuclei far from stability.** (European Organization for Nuclear Research, Geneva (Switzerland)). 15 Jul 1976. 608p. (CONF-760560—). Geneva.

From 3. international conference on nuclides far from stability; Corsica, Italy (19 May 1976).

Individual conference papers appear separately in ERA. (SDF)

11125 (LA-UR—77-2140) **Status of the ENDF/B special applications files.** Stewart, L. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 12p. (CONF-771036—1). Dep. NTIS, PC A02/MF A01.

From 2. ASTM-EURATOM symposium on reactor dosimetry) dosimetry methods for fuels, cladding and structural materials; Palo Alto, California, USA (2 Oct 1977).

The newly formed SAFE Subcommittee of the Cross Section Evaluation Working Group is charged with the responsibility for providing, reviewing, and testing several ENDF/B special purpose evaluated files. This responsibility currently encompasses dosimetry, activation, hydrogen and helium production, and radioactive decay data required by a variety of users. New formats have been approved by CSEWG for the inclusion of the activation and hydrogen and helium production cross-section libraries. The decay data will be in the same format as that already employed by the Fission Product and Actinide Subcommittee of CSEWG. While an extensive dosimetry file was available on the ENDF/B-IV library for fast reactor applications, other data are needed to extend the range of applications, especially to higher incident neutron energies. This Subcommittee has long-range plans to provide evaluated neutron interaction data that can be recommended for use in many specialized applications. 1 figure, 3 tables

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 11127

11126 Excitation of Δ-nuclear states in π-^{4}He scattering. Hirata, M.; Lenz, F.; Yazaki, K. (Department of Physics, Brown University, Providence, Rhode Island). *Ann. Phys. (N.Y.);* **108**: No. 1, 116-164(Sep 1977).

A calculation of π^-—^{4}He scattering in the resonance region is presented. Starting from the optical-model expansion of the multiple scattering formalism, π-nucleus scattering is shown to proceed through the excitation of Δ-nuclear states. Without using the static approximation these Δ-nuclear states are calculated for the π^-—^{4}He system. Our calculations thus include recoil and binding corrections to the elementary amplitude which are used to define the Hamiltonian of the intermediate Δ. Furthermore, second-order contributions arising from the Pauli correlations are taken into account and the modifications due to short-range correlations are calculated. It is shown that each partial wave amplitude in π—^{4}He scattering is dominated by one "collective" Δ-h (Δ-hole) state which exhausts the transition strength to the π-nucleus states. A pole of the S-matrix can be associated to the corresponding collective Δ-h state. On the basis of this resonance description, a qualitative discussion of π—^{4}He scattering is presented. The comparison with the experimental data is used to study the basic couplings of the collective modes to more complicated modes of the π—^{4}He system. Special attention is paid to the coupling of the Δ-h states to purely nuclear states, i.e., to the influence of pion absorption in elastic scattering.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 11322, 11323

11127 Model for estimating (p,π^+) cross sections. Gibb, W.R.; Hess, A.T. (Los Alamos Scientific Lab., N.Mex. (USA)). *Phys. Lett., B;* **68**: No. 3, 205-208(6 Jun 1977).

A model is formulated for estimating the value of the (p,π^+) cross section on a target nucleus by relating it to the elastic π^+ scattering cross section on the same target.

11128 (p,2p) experiments at the University of Maryland Cyclotron. Roos, P.G. (Univ. of Maryland, College Park). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 32-50(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

Recent (p,2p) experiments at the Maryland Cyclotron, and the theoretical analyses. In addition DWIA results are presented which help to establish guidelines for future (p,2p) studies.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 11132, 11133

NUCLEAR REACTIONS AND SCATTERING

11129 Pion non-analog double charge exchange: ^{16}O(π^+,π^-)^{16}Ne. Holt, R.J.; Zeidman, B. (Argonne National Lab., Ill. (USA)); Malbrough, D.J.; Marks, T.; Preedom, B.M. (South Carolina Univ., Columbia (USA)); Baker, M.P.; Burman, R.L.; Cooper, M.D.; Heffner, R.H.; Lee, D.M. *Phys. Lett., B;* **69**: No. 1, 55-57(18 Jul 1977).

The non-analog pion double charge exchange reaction ^{16}O(π^+,π^-)^{16}Ne has been observed. The ground-state differential cross section at 0° is found to be 0.87+-0.21 μb/sr at a mean pion energy of 145 MeV. The mass excess obtained for ^{16}Ne of 24.4+-0.5 MeV is in fair agreement with theoretical predictions. The result indicates that cross sections for pion induced non-isobaric-analog double-charge-exchange transitions can be comparable to those for analog transitions.

11130 High resolution (p,2p) studies at 800 MeV. Cole, R.K. (Univ. of Southern California, Los Angeles). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 174-178(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

Research on high resolution (p,2p) studies on light and intermediate mass nuclei is summarized. (JFP)

11131 Knockout reaction study with a polarized proton beam. Kitching, P.; Miller, C.A.; Hutcheon, D.A.; James, A.N.; McDonald, W.J.; Cameron, J.M.; Olsen, W.C.; Roy, G. (Univ. of Alberta, Edmonton). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 182-186(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

The knockout reaction ^{16}O(p,2p) was studied with a polarized beam at 200 meV. Strong j-dependence of cross section is observed, indicating that under appropriate kinematic conditions knockout protons may be polarized.

11132 Isospin forbidden and allowed reactions ^{16}O(α,α$_0$)^{16}O and ^{16}O(α,γ/sub i/)^{20}Ne. Steck, D.J. Madison, WI; Univ. of Wisconsin (1976). 202p. University Microfilms Order No. 77-8120.

Thesis (Ph. D.).

Differential cross sections were measured for the radiative capture and elastic scattering of alpha particles on ^{16}O for incident beam energies between 6.9 and 10.15 MeV. Narrow resonant struc-

tures were investigated in further detail. Near each of the eight structures, excitation functions were taken simultaneously of both the radiative capture at 90° and the elastic scattering at 14 angles. In addition, an array of NaI crystals measured the on and off resonance angular distributions of the gamma decay at 3 to 7 angles. Resonant energies, widths, and strengths were extracted from the radiative capture excitation functions. Branching ratios calculated from the difference between on and off resonance spectra helped establish limits on the resonance's spin. The elastic scattering data were parameterized in terms of phase shifts. Resonant energies, widths and spins were determined by the final step, a global fit to all data in the resonance region. The results from both reactions were combined to establish a consistent set of parameters for the compound nuclear, ^{20}Ne, levels. Levels at ^{20}Ne excitation energies of 10.26(2+), 11.08(4$^+$), 11.26(1$^-$), and 12.24(2$^+$) MeV were identified as being primarily T = 1. The particle widths (Γ/sub α/: less than or equal to .3, less than or equal to .7, less than or equal to .3, 18 keV) are characteristic of inhibited decay while the gamma decays are quite strong (Γ/sub γ/: 3.8, 3.4, .2, 1.2 eV). Two other possible T = 1 states at E/sub x/ = 11.55 (0$^+$ or 2$^+$) and 12.39(3$^-$) MeV have narrow particle widths but show weaker gamma decay. Analysis of the isospin purity of the T = 1 levels shows that the strength of the mixing force (less than or equal to 30 keV) is well within the capabilities of the Coulomb interaction.

11133 Study of magnetic hyperfine interactions in highly stripped ions by magnetic decoupling experiments. Little, W.A. Stanford, CA; Stanford Univ. (1976). 128p. University Microfilms Order No. 77-7121.

Thesis (Ph. D.).

Magnetic hyperfine interactions in highly stripped light ions produced in nuclear reactions were studied through perturbed angular correlations following recoil into vacuum in the presence of large external axial magnetic fields. The second excited state of ^{16}O (I/sup π/ = 3$^-$, E = 6.13 MeV, tau = 2616 psec, g = 0.55) was studied by use of the ^{19}F(p,) ^{16}O* reaction at bombarding energies of 0.874, 1.374, and 2.026 MeV, and the ^{16}O(α,α′)^{16}O* reaction at 17.55 MeV. Five recoil velocities between 1.0 and 3.3% c were thus obtained, which produced average ionic charge states varying from 1.8 to 5.5. The 6.13-MeV gamma ray de-exciting the 3$^-$ state was observed in coincidence with alpha particles emitted at 180°, giving rise to a large anisotropy in the angular correlation. The anisotropy was observed as a function of an external axial magnetic field for zero to 33 kG. The unperturbed angular correlation was also measured following recoil into a suitable solid backing. The nuclear g-factor and the fraction of nuclei experiencing perturbation have been extracted. The g-factor is consistent with results of other methods; the fraction of nuclei experiencing perturbation is, however, found to be smaller than predicted by the statistical model. This suggests that the L-shell electrons may not be statistically distributed. The technique was also applied to the second excited state of ^{40}Ca(I/sup π/ = 3$^-$, E = 3.73 MeV, tau = 61 psec), populated in the ^{40}Ca(α,α′)^{40}Ca* reaction at a bombarding energy of 16.175 MeV. Again the hyperfine fields appear to be mostly static, and the statistical model based on the M-shell plus the 4s orbital was used. From this analysis a value for the nuclear g-factor of +0.56 +-0.13 was obtained. Although this result if not sufficiently precise to test present nuclear theory, the method is considered as a forerunner to more precise measurements when refined atomic data become available.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 11130

11134 Evidence for the excitation of giant resonances in heavy-ion inelastic scattering. Betts, R.R.; DiCenzo, S.B.; Mortensen, M.H.; White, R.L. (A. W. Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520). *Phys. Rev. Lett.;* **39**: No. 19, 1183-1186(7 Nov 1977).

A study of the inelastic scattering of ^{12}C from ^{27}Al at 82 MeV, a bombarding energy at which deep-inelastic collisions occur, suggests the population of giant resonances in the target. This result supports the suggestion of Broglia, Dasso, and Winther regarding the mechanism of deep-inelastic collisions.

11135 Positron production in heavy-ion collisions. Meyerhof, W.E.; Anholt, R. (Stanford Univ., Calif. (USA). Dept. of Physics); El Masri, Y.; Lee, I.Y.; Cline, D.; Stephens, F.S.; Diamond, R.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Phys. Lett., B;* **69**: No. 1, 41-44(18 Jul 1977).

An experimental method has been developed which can predict the shape and intensity (within a factor of two) of the internal pair conversion positron spectra in heavy-ion nuclear reactions, independent of the production mechanism. To check the method, positron spectra have been measured from bombardments of 624 MeV ^{136}Xe on targets of Th, Au and Al.

11136 Nuclear reorientation effects for the ^{26}Mg, ^{28}Si(^{12}C,^{12}C) reactions at E=41 MeV. Baker, F.T.; Scott, A. (Georgia Univ., Athens (USA)); Gross, E.E.; Hensley, D.C.; Hillis, D.L. (Oak Ridge National Lab., Tenn. (USA)). *Nucl. Phys., A;* **284**: No. 1, 135-144(27 Jun 1977).

Angular distributions for elastic and inelastic scattering of 41 MeV ^{12}C from ^{26}Mg and ^{28}Si have been measured. Corresponding angular distributions from coupled-channels calculations show significant differences depending on whether a prolate or an oblate intrinsic shape is assumed. The ^{26}Mg and ^{28}Si data are best described by calculations with prolate and oblate shapes, respectively, in agreement with previous Coulomb excitation reorientation measurements. The Hendrie scaling procedure fails to accurately predict the measured nuclear β_2 deformation for ^{26}Mg.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 11128, 11139

11137 Helicity flip in the L=1 transfer ^{40}Ca(^{13}C,^{14}N)^{39}K(g.s) reaction. Fuller, R.C. (Brookhaven National Lab., Upton, N.Y. (USA)). *Phys. Lett., B;* **69**: No. 3, 267-271(15 Aug 1977).

Peripherality is invoked to obtain a parametrization of the reaction amplitude in an helicity representation. The resulting angular distribution suggests the L=1 transfer reaction, ^{40}Ca(^{13}C,^{14}N)^{39}K(g.s.), includes spin flip.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 11133

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 11130, 11133

11138 Inelastic scattering of ^{13}C from ^{40}Ca and the L=1 problem. Bond, P.D.; Levine, M.J.; Thorn, C.E. (Brookhaven National Lab., Upton, N.Y. (USA)). *Phys. Lett., B;* **68**: No. 4, 327-329(20 Jun 1977).

Inelastic scattering to the first 3$^-$, 2$^+$ and 5$^-$ states of ^{40}Ca has been measured with a 60 MeV ^{13}C beam. These data indicate that a recent theoretical attempt to reproduce the anomalous L=1 angular distribution in the ^{40}Ca(^{13}C, ^{14}N)^{39}K reaction with a coupled channels calculation overestimates the inelastic scattering to the 3$^-$ and 5$^-$ states in ^{40}Ca by factors of 2.4 and 5, respectively.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

11139 Influence of nucleon mean-free paths on intranuclear cascade results. Ginocchio, J. (Los Alamos Scientific Lab., N.Mex. (USA)); Blann, M. (Rochester Univ., N.Y. (USA). Nuclear Structure Research Lab.). *Phys. Lett., B;* **68**: No. 5, 405-406(4 Jul 1977).

Results of the intranuclear cascade calculation are compared for 62 MeV protons on ^{89}Y and ^{54}Fe targets. Standard calculations and results with mean free paths increased fourfold are compared. The latter set gives poorer results versus experimental data due to an overestimate of nuclear transparency.

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

REFER ALSO TO CITATION(S) 11130

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 11147

ENERGY LEVELS AND TRANSITIONS

11140 Coulomb excitation of ^{115}Sn. Dagenhart, W.K.; Stelson, P.H.; McGowan, F.K.; Robinson, R.L.; Milner, W.T.; Raman, S.; Tuttle, W.K. III (Oak Ridge National Lab., Tenn. (USA)). *Nucl. Phys., A;* **284**: No. 3, 484-500(11 Jul 1977).

Coulomb excitation of the nucleus ^{115}Sn was studied with beams of ^{4}He and ^{16}O. Level energies, spins, mean-lives and B(E2) and B(M1) transition probabilities were obtained. Spin $(3/2)^+$ states were observed at 497.35 and 1280.08 keV and spin $(5/2)^+$ states were observed at 986.54 and 1416.78 keV. A state of 612.79 keV was observed to be indirectly excited by decay of the Coulomb excited states. Eleven B(E2) values and nine B(M1) values were obtained for the transitions between the low-lying states. In contrast to previous particle transfer results which suggested a clear distinction between shell-model and collective $(3/2)^+$ and $(5/2)^+$ states, the results suggest the collective strength is shared by the two $(3/2)^+$ and two $(5/2)^+$ states.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 11140

11141 Investigation of atomic and molecular electronic structure by use of the (e,e') reaction. Bonham, R.A. (Indiana Univ., Bloomington). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 51-76(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

A survey of electron impact spectroscopy in the 20 to 40 keV range is presented. Work on the measurement of Bethe surfaces, charge densities, Compton profiles and inner and outer shell spectroscopy is reviewed.

11142 IU-Melbourne (p,2p) experiments at IUCF. Devins, D.W. (Indiana Univ., Bloomington). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 77-83(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

The motivation for, planning of and current status of the (p,2p) experiments at IUCF are discussed.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

11143 (ORO—3346-214) **Nuclear and x-ray spectroscopy with radioactive sources.** Fink, R.W. (Georgia Inst. of Tech., Atlanta (USA). School of Chemistry). 31 Oct 1977. Contract EY-76-S-05-3346. 37p. Dep. NTIS, PC A03/MF A01.

Research in nuclear chemistry for 1977 is reviewed. The greatest part of the effort was directed to nuclear spectroscopy (systematics, models, experimental studies), but some work was also done involving fast neutrons and x rays from radioactive sources. Isotopes of Tl, Hg, Au, and Eu were studied in particular. Personnel and publications lists are also included. 5 figures, 1 table. (RWR)

11144 Tests for violation of time-reversal invariance in the 922 keV γ-ray of ^{184}W. Murdoch, B.T.; Olsen, C.E.; Steyert, W.A. (Los Alamos Scientific Lab., N.Mex. (USA)). *J. Phys., G (London);* **3**: No. 8, 1093-1098(Aug 1977).

Directional correlations of the strongly hindered 922 keV (E1-M2-E3) γ-ray with the subsequent 253 keV γ-ray of ^{184}W polarised in nickel foils at T = 20 mK showed time-reversal-violating asymmetry equal to $(-7.5 +- 5.9) \times 10^{-4}$. As a result, TRIV components of the E1, M2 and E3 multipole transition matrices appear to be less than approximately 10^{-6}, 10^{-3} and 10^{-3} Weisskopf units respectively.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 11128, 11152

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, THEORETICAL

REFER ALSO TO CITATION(S) 11135

11145 Charge distribution in anomalous nuclei. Voskresenskii, D.N.; Sorokin, G.A.; Chernoutsan, A.I. (L. D. Landau Institute of Theoretical Physics, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 10, 465-468(20 May 1977).

The effect of fermion-charge accumulation on the conditions for the existence anomalous superheavy nuclei and of their properties is investigated.

ENERGY LEVELS AND TRANSITIONS

11146 Survey of single particle states in the mass region A>228. Chasman, R.R.; Ahmad, I.; Friedman, A.M.; Erskine, J.R. (Argonne National Laboratory, Argonne, Illinois 60439). *Rev. Mod. Phys.;* **49**: No. 4, 833-891(Oct 1977).

A deformed single-particle potential mode, with residual interactions, is applied to an analysis of states in odd-mass nuclides with A>228, and configuration assignments are presented for many levels. The systematics of energy level spacings throughout the actinides are studied, and the values of the nuclear deformation parameters that are appropriate to these nuclides are discussed. Tables of occupation probabilities and single-particle matrix elements are provided to facilitate the comparison of future measurements with theoretical expectations.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 11135

SPONTANEOUS AND INDUCED FISSION

11147 (ORNL/NUREG—14) **Fission-product energy release for times following thermal-neutron fission of ^{235}U between 2 and 14000 seconds.** Dickens, J.K.; Emery, J.F.; Love, T.A.; McConnell, J.W.; Northcutt, K.J.; Peelle, R.W.; Weaver, H. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 229p. Dep. NTIS, PC A11/MF A01.

Fission-product decay energy-releases rates were measured for thermal-neutron fission of ^{235}U. Samples of mass 1 to 10 μg were irradiated for 1 to 100 sec by use of the fast pneumatic-tube facility at the Oak Ridge Research Reactor. The resulting beta- and gamma-ray emissions were counted for times-after-fission between 2 and 14,000 seconds. The data were obtained for beta and gamma rays separately as spectral distributions, N(E/sub γ/) vs E/sub γ/ and N(E/sub beta/) vs E/sub β/. For the gamma-ray data the spectra were obtained by using a NaI detector, while for the beta-ray data the spectra were obtained by using an NE-110 detector with an anticoincidence mantle. The raw data were unfolded to provide spectral distributions of modest resolution. These were integrated over E/sub γ/ and E/sub β/ to provide total yield and energy integrals as a function of time after fission. Results are low compared to the present 1973 ANS Decay-heat standard. A complete description of the experimental apparatus and data-reduction techniques is presented. The final integral data are given in tabular and graphical form and are compared with published data. 41 figures, 13 tables.

NUCLEAR THEORY

11148 Pion-exchange contributions to the isoscalar current and magnetic moment operators. Friar, J.L. (Los Alamos Scientific Lab., N.Mex. (USA)). *Phys. Lett., B;* **69**: No. 1, 51-54(18 Jul 1977).

One pion-exchange contributions to the isoscalar current density have been derived with emphasis on the equivalence theorem for pion-nucleon interactions. This current is conserved when used with the non-static OPEP and pion-exchange charge density derived earlier. The exchange charge and current densities satisfy the relativistic four-vector condition. The deuteron pion-exchange magnetic moment operator is also derived.

NUCLEAR STRUCTURE

REFER ALSO TO CITATION(S) 11067, 11158

11149 Introductory guide to effective operators in nuclei. Ellis, P.J.; Osnes, E. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455). *Rev. Mod. Phys.;* **49**: No. 4, 777-832(Oct 1977).

In this tutorial-style article we discuss the time-independent perturbation formalism of Brandow for effective interactions and operators in a nonrigorous, intuitive way. The simple example of a 2 x 2 matrix is used to introduce the basic concepts, for instance the notion of folded diagrams. The same example is used subsequently in a discussion of the branch points arising from "level crossings" and the associated convergence difficulties with the perturbation series. Numerical calculations of the effective interaction and the effective charge are then reviewed, focussing, for the most part, on the (1s0d)

shell. Whenever possible, simple physical models are used to illustrate the results. A fairly comprehensive summary of the calculations to date is given, and we attempt to synthesize and draw conclusions.

11150 Field theory of collective excitations. I. A soluble model. Kleinert, H. (Los Alamos Scientific Lab., N.Mex. (USA)). *Phys. Lett., B;* **69**: No. 1, 9-12(18 Jul 1977).

Collective fields are introduced into fermion Lagrangians and graphical rules for a joint treatment of both types of excitations are derived via Feynman path integrals. For the soluble degenerate-shell model with pairing forces used in nuclear and many-body physics the exact collective action is exhibited.

11151 Calculation of E1 radiative strength functions in semimagic nuclei. Voronov, V.V.; Solov'ev, V.G.; Stoyanov, C. (Joint Institute for Nuclear Research). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 9, 430-432(5 May 1977).

The E1 radiative strength functions of a number of semimagic nuclei are calculated within the framework of a semimicroscopic approach, and the results are compared with the experimental data. The calculations do not employ free parameters. A good description of the experimental data was obtained.

NUCLEAR REACTIONS AND SCATTERING

11152 (LBL—6592) Polarizability of nuclear wave functions in heavy ion reactions. Charlton, L.A.; Delic, G.; Glendenning, N.K.; Pruess, K. (California Univ., Berkeley (USA)). Aug 1977. Contract W-7405-ENG-48. 18p. (CONF-770968—4). Dep. NTIS, PC A02/MF A01.

From International conference on nuclear structure; Tokyo, Japan (5 Sep 1977).

Evidence is presented for the polarizability of nuclear wave functions in heavy-ion transfer reactions. The polarization of the wave function of the transferred nucleon is largest for weakly bound nucleons, depends on the bombarding energy (being largest for low-energy (slow) collisions) and produces a shift toward forward angle. Results of an adiabatic estimate employing two-center-shell-model wave functions in a DWBA amplitude are presented. A dynamical theory is sketched which involves a superposition of many transitions through excited bound and continuum states of the weakly bound nucleon. It is shown how the adiabatic amplitude emerges as the lowest approximation. 7 figures.

11153 Multiple scattering with three-body forces. Austern, N. (Department of Physics, University of Washington, Seattle, Washington 98195). *Ann. Phys. (N.Y.);* **108**: No. 2, 401-407(Oct 1977).

The multiple-scattering formalism is generalized to account for simultaneous interactions of a projectile with two target particles. In the cluster expansion of multiple-scattering theory such three-body interactions combine with iterates of two-body interactions. Some comparisons of multiple scattering with the Faddeev theory are given.

11154 Intermediate energy nuclear reactions. Walker, G.E. (Indiana Univ., Bloomington). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 21-31(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

Intermediate energy electron, photon, pion, kaon, and proton reactions are discussed and compared. Special emphasis is placed on the complementarity of the various probes. Production of an intermediate nucleon resonance is proposed as a mechanism for understanding the recent medium energy (γ,p) results.

11155 Quasi-free (π,πN) scattering. Herscovitz, V.E.; Maris, T.A.J.; Mors, P.M.; Schneider, C.S. (Instituto de Fisica, Porto Alegre, Brasil). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 179-181(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

Quasi-free (π,πN) scattering in the resonance region is discussed.

11156 Three-body collisions involving breakup. Sloan, I.H. (Univ. of New South Wales, Sydney). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 187-194(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

A nontechnical introduction is given to breakup processes caused by a particle incident on a bound pair. A brief discussion of the theory is followed by a review of exact calculations and approximation methods. One concludes with a short discussion of the special problems arising when the particles are charged.

11157 Distorted wave calculations for (p,2p) reactions. Koshel, R.D. (Ohio Univ., Athens). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 227-239(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

The theoretical work that is being done and in the planning stage in a study of (p,2p) reactions using the distorted wave impulse approximation (DWIA) is discussed. Some of this work is only in its preliminary stages. The results of a few calculations are shown. It is the primary purpose to discuss various aspects of the work which involves what is believed to be the major uncertainties in such a study. As a result the following topics are discussed in varying degrees and not in the order shown: distorted wave effects in (p,2p) reaction, off-the-energy shell behavior of the nucleon-nucleon t matrix, the calculation of the optical model from the nucleon-nucleon interaction, multistep processes. The work discussed is based on the knockout formalism developed by Kazaks and Koshel. (JFP)

11158 Special aspects of the nuclear problem. Thaler, R.M. (Case-Western Reserve Univ., Cleveland). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 36, 263-271(1977).

From Workshop on the determination of momentum wavefunctions; Bloomington, Indiana, USA (31 May 1976).

See CONF-760567—.

One begins the treatment of the nuclear problem by discussing scattering, in the case where there are only two body forces. In that case we may write T =Σ/sub i/ v/sub oi/ + Σ/sub i/ v/sub oi/ G/sub o/ T. This is an operator equation which requires a great deal of careful discussion, all of which we shall ignore for the purpose at hand. All I want to stress now is that if we find T, we know the scattering amplitude, etc. Also the electron and pion as probes of nuclei are treated. (JFP)

RADIOACTIVE DECAY

11159 Radioactivity's two early puzzles. Pais, A. (Rockefeller University, New York, New York 10021). *Rev. Mod. Phys.;* **49**: No. 4, 925-938(Oct 1977).

Since the discovery of radioactivity predates the birth of quantum mechanics by nearly thirty years, it was inevitable that the most fundamental aspect of radioactive processes, its spontaneity, was also the most baffling one to physicists during the first quarter of the twentieth century. The ensuing struggles in that period with regard to the origins of the radioactive energy release, and to the significance of the life time concept are discussed.

NUCLEAR MODELS

REFER ALSO TO CITATION(S) 11150

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

11160 Measurements of the additivity of stopping cross-sections for 50-150 keV protons in nine hydrocarbon gases. Thorngate, J.H. (Oak Ridge National Lab., Tenn. (USA)). *Health Phys.;* **32**: No. 6, 541-546(Jun 1977).

Molecular stopping cross-sections were calculated using the mean energies of energy-loss distributions measured for 51, 76.5, 102, 127.5 and 150 keV protons traversing methane, ethyne, ethene, ethane, propyne, propadiene, propene, cyclopropane and propane. Carbon stopping cross-sections, calculated from the data using Bragg-Kleeman additivity, showed variations that could be correlated to the type of carbon-carbon bonding in the gas molecules. At 51 keV, the calculated carbon stopping cross-sections were 9.5 +- 0.4, 13.0 +- 0.4 and 16.0 +- 0.5 (x 10^{15} eV-cm^2 molecule $^{-1}$) for gases that had only single double or triple bonds, respectively. Gases with mixed bonds gave intermediate values. The widths of the energy loss distributions could also be correlated to the type of carbon-carbon bonding in the molecules.

SHIELDING CALCULATIONS AND EXPERIMENTS

REFER ALSO TO CITATION(S) 10212

11161 Iron-water combination for shielding of 14 MeV neutrons. Shani, G. (Ben-Gurion Univ. of the Negev, Beersheba (Israel). Dept. of Nuclear Engineering). *Ann. Nucl. Energy;* **4**: No. 2, . 65-67(1977).

The best way to achieve good shielding of 14 MeV neutrons is investigated. The idea is to thermalize as many neutrons as possible with a given shielding thickness. Since hydrogenous material is not efficient for thermalization of 14 MeV neutrons the neutrons are first slowed down with iron to an energy range where hydrogen is more

efficient for thermalization. Layers of iron and water of various thickness that add up to 14 cm were investigated and it was found that a composition of 7 cm of iron and 7 cm of water gives the highest number of thermal neutrons. The fast flux leaking out of the shielding is decreased continuously with increasing iron thickness. A thin layer of water after the iron layer is enough to increase the number of thermal neutrons considerably.

NEUTRON INTERACTIONS WITH MATTER

REFER ALSO TO CITATION(S) 10293, 10306, 10311, 10313, 10314, 10315, 10317

11162 Compatible product angular quadrature for neutron transport in x-y geometry. Abu-Shumays, I.K. (Bettis Atomic Power Lab., West Mifflin, PA). *Nucl. Sci. Eng.;* **64**: No. 2, 299-316(Oct 1977).

The main features of this paper are the utilization of inherent two-dimensional symmetries and the development of accurate angular quadrature coordinates and weights especially suited for the net and/or partial currents and all the net and/or partial moments of the neutron flux up to a given order. Three classes of true analogs of the one-dimensional single-Gauss and double-Gauss are considered for two-dimensional x-y problems with rectangular spatial mesh subdivisions. The first is single-range quadrature, most suitable for the asymptotic regions where the vector flux of neutrons can be well approximated by polynomials in Ω/sub x/ and Ω/sub y/ defined over the entire unit sphere of angular directions Ω. This quadrature can be used whenever distances between material interfaces are large with respect to the neutron mean-free-path (mfp). The second is double-range quadrature, most suitable at material interfaces where the unit sphere can be split into two hemispheres, one in each material region, and the vector flux can be well approximated by two possibly distinct polynomials in Ω/sub x/ and Ω/sub y/, one in each hemisphere. This quadrature can be used whenever material interfaces and currents are important along either the x or the y direction but not both. The third is quadruple-range quadrature, most suitable at corners where the unit sphere can be split into four quadrants and the vector flux can be well approximated by four possibly distinct polynomials in Ω/sub x/ and Ω/sub y/, one in each quadrant. This quadrature explicitly allows for discontinuities at corners and is appropriate for highly heterogeneous problems where distances between material corners are small with respect to the mfp. For simplicity, only product formulas are considered, where the angular integrals are split into separate integrals over polar and azimuthal directions.

11163 Application of space-angle synthesis to two-dimensional neutral-particle transport problems of weapon physics. Roberds, R.M. (Air Force Weapons Lab., Kirtland AFB, NM); Bridgman, C.J. *Nucl. Sci. Eng.;* **64**: No. 2, 332-343(Oct 1977).

A space-angle synthesis (SAS) method is developed for the steady-state, two-dimensional transport of neutrons and secondary gamma rays from a point source of simulated nuclear-weapon radiation in air. The method is validated by applying it to the problem of neutron transport from a point source in air over a ground interface, and then comparing the results to those obtained by DOT, a discrete-ordinates code. In the method, the energy dependence of the Boltzmann transport equation is treated in the standard multigroup manner. The angular dependence is treated by expanding the flux in specially tailored trial functions and applying the method of weighted residuals that analytically integrates the transport equation over all angles. The trial functions used in the expansion are composed of combinations of selected trial solutions, the trial solutions being shaped ellipsoids that approximate the angular distribution of the neutron flux in one-dimensional space. Differences between DOT and SAS tissue-dose calculations at distances greater than 60 m from the source were generally under 10 percent and decreased with increasing source or receiver height. Computer computational time was decreased by a factor of approximately 7.

11164 Diffusion synthetic acceleration methods for the diamond-differenced discrete-ordinates equations. Alcouffe, R.E. (Los Alamos Scientific Lab., NM). *Nucl. Sci. Eng.;* **64**: No. 2, 344-355(Oct 1977).

A class of acceleration schemes are investigated that resemble the conventional synthetic method in that they utilize the diffusion operator in the transport iteration schemes. These schemes are not dependent on diffusion theory as being a good approximation to transport theory; they only make use of the diffusion equation form. The accelerated iteration involves alternate diffusion and transport solutions where coupling between the equations is achieved using a correction term applied to either (a) the diffusion coefficient, (b) the removal cross section, or (c) the source of the diffusion equation. The methods involving the modification of the diffusion coefficient and of the removal term yield nonlinear acceleration schemes and are used in k/sub eff/ calculations, while the source term modification approach is linear at least before discretization and is used for inhomogeneous source problems. A careful analysis shows that there is a preferred differencing method that eliminates the previously observed instability of the conventional synthetic method. Using this preferred difference scheme results in an acceleration method that is at the same time stable and efficient. This preferred difference approach renders the source correction scheme, which is linear in its continuous form and nonlinear in its differenced form. An additional feature of these approaches is that they can be used as schemes for obtaining improved diffusion solutions for approximately twice the cost of a diffusion calculation. Numerical experimentation on a wide range of problems in one and two dimensions indicates that improvement from a factor of from 2 to 10 over rebalance or Chebyshev acceleration is obtained. The improvement is most pronounced in problems with large regions of scattering material where the unaccelerated transport solutions converge very slowly.

11165 Neutron kerma factors for H, C, N, O and tissue in the energy range of 20-70 MeV. Alsmiller, R.G. Jr.; Barish, J. (Oak Ridge National Lab., Tenn. (USA)). *Health Phys.;* **33**: No. 1, 98-100(Jul 1977).

Calculated neutron kerma factors for H, C, N, O and tissue in the energy range of 20 to 70 MeV are presented. The available experimental data on charged-particle production from neutron interactions with C, N and O nuclei at energies $>=$ 20 MeV are very limited, and thus the results presented here are based almost entirely on theoretical cross-section data. The method of calculation is briefly discussed, and the results are presented as kerma per unit fluence given as a function of energy for H, C, N, O and tissues. The results are discussed and compared to those of other workers.

11166 (ORNL-tr—4465) **ANIGAM: a program system to automatically calculate nuclear group data.** Baltes, B.; Kramer, E.; Lugenheim, V. Aug 1976. Translation of JUL—1327 by T.W. Appich, Jr. 41p. Dep. NTIS, PC A03/MF A01.

The computer code ANIGAM consists mainly of the well-known programs GAM-I and ANISN, as well as of a subroutine which reads the THERMOS cross-section library and prepares it for ANISN. ANIGAM was written for the automatic calculation of microscopic and macroscopic cross sections of light-water-reactor fuel assemblies. In a single computer run both were calculated, the cross sections representative for fuel assemblies in reactor core calculations and the cross sections of each cell type of a fuel assembly. The calculated data were delivered to EXTERMINATOR and CITATION for following diffusion or burn-up calculations by an auxiliary program. This report contains a detailed description of the computer codes and methods used in ANIGAM, a description of the subroutines, of the OVERLAY structure, and of input and output. 4 figures.

11167 Monte Carlo study of the mechanisms of transport of fast neutrons in various media. Ku, L. New York; Columbia Univ. (1976). 185p. University Microfilms Order No. 77-8868.

Thesis (Ph. D.).

The technique of analyzing Monte Carlo histories was used to study the details of neutron transport and slowing down mechanisms. The statistical properties of life histories of "exceptional" neutrons, i.e., those staying closer to the source or penetrating to larger distances from the source, were compared to those of the general population. The macroscopic behavior of "exceptional" neutrons was also related to the interaction mechanics and to the microscopic properties of the medium.

MEDICAL PHYSICS

DOSIMETRY

11168 (UCID—17615) **GANDALF: users' manual.** Strout, R.E. II; Beach, J.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Oct 1977. Contract W-7405-ENG-48. 17p. Dep. NTIS, PC A02/MF A01.

The GANDALF computer code was written to calculate neutron dose equivalent given the pulse-height data obtained by using a Linear Energy Transfer (LET) proportional counter. The code also uses pre- and/or post-calibration spectra, from an alpha source, to determine a calibration factor in keV/μ/channel. Output from the code consists of the effective radius of the detection chamber in microns, a calibration factor in keV/μ/channel, and the total dose and dose equivalent in rad or rem between any two LET energies by using the equations by Attix and Roesch [Radiation Dosimetry, 1, 71 (1968)]. This report is a user's manual and is not intended as anything else, and assumes that the user has a basic knowledge of the LLL Octopus timesharing system. However, a very brief description of how the code operates is included.

11169 Physical characterization of neutron beams produced by protons and deuterons of various energies bombarding beryllium and lithium targets of several thicknesses. Amols, H.I.; Dicello, J.F.; Awschalom, M.; Coulson, L.; Johnsen, S.W.; Theus, R.B. (Universi-

ty of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Med. Phys.;* **4**: No. 6, 486-493(Nov 1977).

Protons of 35 and 65 MeV and deuterons of 35 MeV were used to bombard beryllium and lithium targets of various thicknesses. Four types of experiments were conducted in order to characterize the neutron fields. They were (1) central axis depth-dose measurements in a water phantom, (2) dose buildup at small depths in tissue-equivalent plastic, (3) microdosimetric measurements and LET distributions, and (4) neutron yields and energy spectra at an angle of 0 deg. The results generally show that (a) the central axis depth doses for the 35 and 65 MeV particles roughly approximate those of ^{60}Co and 4-MeV bremsstrahlung photons, respectively, (b) the neutron dose buildups are more rapid than those of the above-mentioned photon sources, (c) the microdosimetric spectra show differences which are consistent with the measured neutron energy spectra, and (d) p—Li compared to p—Be neutron spectra have larger high-energy particle flux for similar target and beam configurations.

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 10719, 11047

11170 (UCRL—80341) **Computer simulation at high pressure.** Alder, B.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nov 1977. Contract W-7405-ENG-48. 14p. Dep. NTIS, PC A02/MF A01.

The use of either the Monte Carlo or molecular dynamics method to generate equations-of-state data for various materials at high pressure is discussed. Particular emphasis is given to phase diagrams, such as the generation of various types of critical lines for mixtures, melting, structural and electronic transitions in solids, two-phase ionic fluid systems of astrophysical interest, as well as a brief aside of possible eutectic behavior in the interior of the earth. Then the application of the molecular dynamics method to predict transport coefficients and the neutron scattering function is discussed with a view as to what special features high pressure brings out. Lastly, an analysis by these computational methods of the measured intensity and frequency spectrum of depolarized light and also of the deviation of the dielectric measurements from the constancy of the Clausius—Mosotti function is given that leads to predictions of how the electronic structure of an atom distorts with pressure.

11171 **Thermally activated hopping in granular films and powders.** Simanek, E. (Univ. of California, Riverside). *Phys. Lett., A;* **59**: No. 3, 231-232(29 Nov 1976).

A mechanism involving carrier—carrier interaction is proposed for intergrain hopping of electrons in thin films and fine particle powders. The calculated hopping rate yields large broadening of electron levels in fine particle samples.

11172 **Theory and numerical calculation of the acoustic field produced in metal by an electromagnetic ultrasonic transducer.** Kawashima, K. (Oak Ridge National Lab., TN). *J. Acoust. Soc. Am.;* **60**: No. 5, 1089-1099(Nov 1976).

The equations for calculating the acoustic field produced within a nonmagnetic metal by an interaction of eddy current with a static magnetic field were obtained on the assumptions that an ultrasonic wave is generated by the electromagnetic force through classical and macroscopic phenomena; the electric, magnetic, and elastic properties of the metal are linear, isotropic, and homogeneous throughout the metal, which occupies semi-infinite space; the whole system is axially symmetric; and eddy currents and elastic waves show a steady-state sinusoidal variation. The acoustic field produced by a specific electromagnetic ultrasonic transducer with axial symmetry was calculated numerically, and the results showed a well-defined ultrasonic wave beam, which was narrower than had been expected from the size of the transducer. 14 figures, 5 tables.

SUPERCONDUCTIVITY

GENERAL THEORY

11173 **Resistive domain in long superconductor of small cross section at temperatures close to critical.** Kashchei, V.A. (Institute of Radiophysics and Electronics, Academy of Sciences of the Ukrainian SSR Khar'kov). *Sov. Phys. - Solid State (Engl. Transl.);* **19**: No. 6, 934-938(Jun 1977).

The singularities of the resistive current state of a long superconductor of small cross section are investigated in terms of the electron heating in metals at temperatures 1-tvery-much-less-than1, where t is the sample temperature in units of its critical temperature T/sub C/. The conditions under which a resistive domain is produced in such a superconductor are elucidated. The critical length of the resistive domain was found to be L/sub R/(t) ~λ/sub Theta(t)/ where and l/sub M/(T/sub c/) is electron mean free path in the bulky superconductor at T =T/sub C/, l is the mean free path of the electrons in the sample, k/sub B/ is Boltzmann's constant, s is the speed of longitudinal sound in the metal, and p/sub F/ is the Fermi momentum. The possibility of obtaining an estimate for the microscopic quantities that enter in L/sub R/(t) is noted. Within the framework of the developed concepts, the minimum voltage drop across a long superconductor with small cross section in the resistive state is given by where Θ/sub C/ is determined from the equation Θ/sub C/-t= (8/5) β (1-Θ/sub C/)^3, where β is a constant that depends on the microscopic parameters of the metal. The results of the calculations are in good quantitative agreement with earlier measurements performed on superconducting whiskers and thin films.

THEORETICAL PHYSICS

CLASSICAL AND QUANTUM MECHANICS

11174 **Bound states of weakly coupled long-range one-dimensional quantum Hamiltonians.** Blankenbecler, R.; Goldberger, M.L.; Simon, B. (Department of Physics, Princeton University, Princeton, New Jersey 08540). *Ann. Phys. (N.Y.);* **108**: No. 1, 69-78(Sep 1977).

We study the small λ behavior of the ground state energy, E (λ), of the Hamiltonian -(d^2/dx^2)+λV (x). In particular, if V (x) ~-ax^{-2} at infinity and if ∫ V (x) dx<0, we prove that (-E (λ))/sup 1/2/ =-[1/2λ+aλ^2 lnλ] ∫ dxV (x)+O (λ^2).

ACOUSTICS

11175 **Decay of reverberant sound in a spherical enclosure.** Carroll, M.M.; Chien, C.F. (Department of Mechanical Engineering, University of California, Berkeley, California 94720). *J. Acoust. Soc. Am.;* **62**: No. 6, 1442-1446(Dec 1977).

The assumption of diffuse reflection (Lambert's Law) leads to integral equations for the wall intensity in a reverberant sound field in the steady state and during decay. The latter equation, in the special case of a spherical enclosure with uniformly absorbent walls and uniform wall intensity, allows exponential decay with a decay time which agrees closely with the Norris—Eyring prediction. The sound-intensity and sound-energy density in the medium, during decay, are also calculated.

OPTICS

11176 **Stimulated Raman spectroscopy using low-power cw lasers.** Owyoung, A.; Jones, E.D. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Opt. Lett.;* **1**: No. 5, 152-154(Nov 1977).

It is demonstrated that stimulated Raman spectroscopy (SRS) can be performed using cw dye lasers at power levels over six orders of magnitude smaller than those generally associated with pulsed stimulated Raman studies. The preliminary results suggest that cw SRS is a potentially powerful alternative to conventional spontaneous Raman scattering, with resolution limited solely by laser linewidth and sensitivity independent of resolution requirements.

11177 **Sensitivity enhancement of a spin-flip Raman laser absorption spectrometer through use of an intracavity absorption cell.** Dutta, N.; Warner, R.T.; Wolga, G.J. (Cornell University, Ithaca, New York 14853). *Opt. Lett.;* **1**: No. 5, 155-157(Nov 1977).

Gas-phase molecular spectroscopy is performed with a cw, external-cavity spin-flip Raman laser containing an intracavity absorption cell. Significantly enhanced sensitivity is demonstrated under marginal oscillator conditions obtained by decreasing the laser gain to a level comparable with the absorption loss of the cell. Spectra of nitric oxide and carbonyl sulfide are discussed to illustrate the performance achieved.

STATISTICAL PHYSICS AND THERMODYNAMICS

REFER ALSO TO CITATION(S) 10716

ELECTRICITY AND MAGNETISM

11178 (UCID—17511) **Data characterization and compression.** Miller, E.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Jul 1977. Contract W-7405-ENG-48. 24p. Dep. NTIS, PC A02/MF A01.

The extraction of information from measured or computed data is all-pervasive; to gain the most value from extracted information, it must often be transformed from one type of data into another, a process that can only preserve or lose information. An information-transformation process based upon Prony's method was found to be increasingly useful for application to electromagnetic-type problems in particular and a growing variety of physical problems in general. This procedure allows the coefficients and exponents (or parameters) of an exponential series to be derived from a sequence of

its sampled values. Two basic issues are associated with Prony processing: determination of the status of the input data and application of the procedure as effectively as possible to maximize the information content of the output. The possible uses of the Prony method as an information on-transformation process are discussed; the insight gained from this viewpoint concerning the information content of data is emphasized. Waveform and spectrum characterization, data compression, and inversion of pattern data are considered briefly as applications. 8 figures, 3 tables. (RWR)

MATHEMATICAL PHYSICS

REFER ALSO TO CITATION(S) 11178

11179 (UCRL—52329) **Information extraction using Prony's method.** Miller, E.K.; Lager, D.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Aug 1977. Contract W-7405-ENG-48. 19p. Dep. NTIS, PC A02/MF A01.

Prony's method is a technique for determining the coefficients (poles and residues in the frequency domain) of an exponential series. Recently, applications of this method have been considered in electromagnetics because it offers the possibility of obtaining the SEM poles of conducting objects from their transient response. In addition, Prony's method offers insight into the general problem of extracting useful information from one-dimensional data. In particular, Prony's method can be viewed as a transformation of data from one form to another. The amount of information extractable from transformed data can be as much as or less than that in the original data. Clearly, retention of the greatest possible amount of information in the transformed data is desirable. Thus, in order to evaluate the information-transformation process, one must determine the amount of information in the original data and in the transformed data. This report considers these questions of information content and data transformation. To define information content, concepts of data rank (number of poles in the exponential data) and data precision are used. Then, to study data transformation, a waveform is defined in terms of specified poles and residues, the waveform is sampled to obtain the associated data, and Prony's method is used to transform the data and compare it with the originalinformation content. Other numerical processes, such as matrix inversion, can be viewed in the same way. Problems of ill-conditioning are related more to the data than to the process. Finally, applications of Prony's method to other physical problems with exponential solutions are briefly considered. 12 figures.

11180 (UCRL—80094) **Role of statistical linearization in the solution of nonlinear stochastic equations.** Budgor, A.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Aug 1977. Contract W-7405-ENG-48. 37p. (CONF-770692—2). Dep. NTIS, PC A03/MF A01.

From International conference on stochastic behavior and quantum hamiltonian systems; Tremezzo, Italy (20 Jun 1977).

The solution of a generalized Langevin equation is referred to as a stochastic process. If the external forcing function is Gaussian white noise, the forward Kolmogarov equation yields the transition probability density function. Nonlinear problems must be handled by approximation procedures e.g., perturbation theories, eigenfunction expansions, and nonlinear optimization procedures. After some comments on the first two of these, attention is directed to the third, and the method of statistical linearization is used to demonstrate a relation to the former two. Nonlinear stochastic systems exhibiting sustained or forced oscillations and the centered nonlinear Schroedinger equation in the presence of Gaussian white noise excitation are considered as examples. 5 figures, 2 tables. (RWR)

FUSION ENERGY

PLASMA RESEARCH

PLASMA CONFINEMENT AND HEATING

REFER ALSO TO CITATION(S) 10301

11181 (ECN—16) **Parameter study of a screw-pinch reactor with circular cross-section.** Bustraan, M.; Franken, W.M.P.; Klippel, H.Th.; Muysken, M.; Verschuur, K.A.; Bobeldijk, C.; Hoekzema, J.A.; Schuurman, W.; Damstra, G.C.; Klein Nibbelink, H.J. (Stichting Energieonderzoek Centrum Nederland, Petten). Apr 1977. 51p. Dep. NTIS (US Sales Only), PC A04/MF A01.

In the framework of system studies on pulsed high-β fusion reactors, a parameter study of a reactor based on a screw pinch with a circular cross-section has been performed. The plasma is heated to ignition in two stages. First, the cold plasma is heated by fast implosion in order to guarantee pitch conservation of the inward moving magnetic field lines. The relevant implosion theory has been generalized to a $\beta<1$ plasma. In the second stage, an adiabatic compression heats the plasma to the ignition temperature at which point α-particle heating takes over. For stability reasons, β is kept below 0.25. The choice of a particular set of basic parameter values is justified by global design considerations of the reactor. These considerations, e.g. on blanket design and electrotechnical requirements, are presented in some detail. A computer program searches for optimal reactors, i.e. for which at a given thermal output the net efficiency is a maximum. The parameters of a Reference Screw-Pinch Reactor and some other numerical examples are given. The main conclusions are: the net efficiency, although increasing with output energy, is low because of ohmic losses in the compression coil system; the application of sustained fields generated by superconducting coils to reduce these ohmic losses is problematical; a belt-shaped screw pinch in which higher values of β may be reached, improves the net efficiency and alleviates the technical requirements; heating by implosion and adiabatic compression of a plasma with values of β as low as considered here, is inefficient. Therefore, other means of heating the plasma to ignition may be attractive.

11182 (EUR-CEA-FC—868) **Oxygen gas injection during the current plateau of a T.F.R. Tokamak plasma.** (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Dec 1976. 65p. Dep. NTIS (US Sales Only), PC A04/MF A01.

Oxygen gas was injected during the current plateau of a quasi-stationary T.F.R. deuterium plasma. As a consequence of the injection, the molybdenum density inside the plasma decreased, apparently because of a decreased molybdenum flux entering the plasma. The decrease in the density has a time constant which is a measurement of the impurity particle confinement time tausub(p). In this way, the confinement time was measured, values obtained were tausub(p)=50msec at the plasma center, and tausub(p)=20msec at the periphery. The discharges studied has been simulated by using different forms of the anomalous impurity diffusion. It is concluded that, under the conditions imposed by the experiments, the anomalous diffusion used must be proportional to the impurity density gradients.

11183 (KFTI—76-7) **Turbulent current heating of dense plasma.** Suprunenko, V.A.; Sukhomlin, E.A.; Volkov, E.D.; Perepelkii, N.F. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1976. 32p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

Based upon experimental results an attempt is made for systematizing and analysing conditions of experiments in anomalous resistance and turbulent heating of a plasma. The extensive program of such investigations aims at a direct practical study on quasistationary heating and plasma containment in magnetic traps. It has been shown that in real conditions turbulent heating turns out to be a far more complicated phenomenon than that described within the framework of theories developed so far. It has been established that the phenomenon alters in the transition through the critical values of electric and magnetic fields. This makes it possible to separate four characteristic experimental regimes. For all the regimes the stabilization of the electron current drift rate is typical. On the basis of the experimental results obtained an explanation is given of the sporadic character of the ultrathermal radiation in a quasistationary discharge.

11184 (Rijnhuizen—77-102) **Field penetration in the TORTUR II liner.** Piekaar, H.W.; de Kluiver, H. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Apr 1977. 11p. Dep. NTIS (US Sales Only), PC A02/MF A01.

In the turbulently heated tokamak TORTUR, the influx of neutrals from the quartz discharge vessel led to a four- to tenfold increase in electron density and to rapid exchange of the hot ion population. The rapid formation of a current skin and the subsequent heating of this skin by current-driven turbulence has been studied. If plasma containment is to be extended beyond 150 μs, replacement of the quartz by a stainless-steel liner is deemed to be inevitable. A high-temperature coating as another method to inhibit the flux of neutrals might be the coating of the quartz surfaces of the discharge vessel with a material known to have superior properties with regard to the adsorption of gas. Whether or not the induced voltages required for turbulent heating will penetrate sufficiently through the conducting liner will be determined by its properties and dimensions. Discussions of the penetration of a field through a liner enclosed in a segmented copper shell, and the current wave-forms to be expected, are given.

11185 **Parametric instabilities due to lower-hybrid radio frequency heating of tokamak plasmas.** Porkolab, M. (Max-Planck-Institut fuer Plasmaphysik, D-8046 Garching bei Muenchen, Germany). *Phys. Fluids;* **20**: No. 12, 2058-2075(Dec 1977).

The linear theory of parametric instabilities relevant to radio-frequency heating near the lower-hybrid frequency of tokamak-type plasmas is presented. The dispersion relations are analyzed numerically to all orders of the ion Larmor radius. The complete range of unstable spectra is obtained for $1<\omega_0/\omega/\text{sub 1 h}/<5$, for both deuterium and hydrogen plasmas. As the pump wave propagates from the edge of the plasma toward its interior, the transition from resonant decay to decay into quasi-modes is demonstrated. The effects of inhomogeneities upon the threshold for parametric decay, such as density gradients, finite pump width, and magnetic shear, are obtained. The relevance of these results to recent tokamak experiments is discussed briefly.

11186 Magnetosonic waves in the presence of a lower hybrid turbulence and plasma heating. Sinha, M.; Goswami, B.N. (Physical Research Laboratory, Ahmedabad 380009, India). *Phys. Fluids;* **20**: No. 12, 2145-2147(Dec 1977).

A theoretical investigation has shown that energy could be fed into a microturbulence from an externally excited low frequency magneto-acoustic source. A magnetosonic wave, normally undamped in a quiescent plasma, is shown to be damped in the presence of a lower hybrid microturbulence which in turn effectively heats the plasma ions. This process does not require any threshold amplitude of the external pump wave and therefore, very small amplitude waves can deposit their energy into the plasma unlike the usual parametric heating schemes which demand a minimum threshold amplitude.

11187 Scattering of relativistic electron beams by magnetic field errors and beam-induced waves. Benford, G. (Physics Department, University of California, Irvine, California 92717). *J. Appl. Phys.;* **48**: No. 12, 4968-4972(Dec 1977).

Relativistic electron beams propagating in long plasma columns must be well focused to cause efficient plasma heating. Expansion of the beam area due to scattering lowers efficiency. We calculate the beam spreading expected from errors in the ambient magnetic field. We then include scattering from both electrostatic and magnetic waves generated by the beam itself. All these effects can be important in contemplated experimental regimes. However, it may prove possible to "tune" beam-plasma heating processes to avoid significant beam spreading.

11188 Sum-frequency excitation of electron plasma waves. Willett, J.E.; Maraghechi, B.; Zorinsky, E.J. (Department of Physics, University of Missouri-Columbia, Columbia, Missouri 65201). *J. Appl. Phys.;* **48**: No. 12, 5008-5013(Dec 1977).

Nonlinear mixing of two circularly polarized electromagnetic waves propagating in a plasma along a uniform static magnetic field is considered. Resonant excitation of electron plasma waves is found to be possible at the difference frequency if the incident waves are both extraordinary or both ordinary and at the sum frequency if one incident wave is extraordinary and the other is ordinary. Formulas for the absorption efficiency due to sum-frequency excitation are derived and the results of a numerical study are presented.

11189 Angle-dependent reflectance of laser-produced plasmas. Godwin, R.P.; Sachsenmaier, R.; Sigel, R. (Projektgruppe fuer Laserforschung der Max-Planck-Gesellschaft zur Foerderung der Wissenschaften, D-8046 Garching, Federal Republic of Germany). *Phys. Rev. Lett.;* **39**: No. 19, 1198-1201(7 Nov 1977).

The reflectance of planar targets irradiated by 400-mJ, 30-ps Nd: glass laser pulses was measured as a function of angle of incidence and polarization with an Ulbricht spherical photometer. At normal incidence we find reflectances >0.6. The reflectance for p-polarized light has a minimum at an incidence angle 20° to 30°, for angles greater than 60° total reflection occurs for both s- and p-polarized light. The results seem consistent with simulations.

11190 Measurement of density modification of laser-fusion plasmas. Azechi, H.; Oda, S.; Tanaka, K.; Norimatsu, T.; Sasaki, T.; Yamanaka, T.; Yamanaka, C. (Institute of Laser Engineering, Osaka University, Suita, Osaka 565, Japan). *Phys. Rev. Lett.;* **39**: No. 18, 1144-1147(31 Oct 1977).

Density profile of the glass-microballoon plasma irradiated by Nd laser with intensity of 10^{16} W/cm^2 was measured by newly developed microscopic interferography. The existence of strong density modification by intense radiation pressure was clearly indicated.

11191 Soliton generation at resonance and density modification in laser-irradiated plasmas. Chen, H.; Liu, C. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Rev. Lett.;* **39**: No. 18, 1147-1151(31 Oct 1977).

Analytic results are obtained for generation of solitons and their effects on density-profile modifications at critical density for resonance absorption process.

11192 Numerical resolution of the full dispersion relation for a warm magnetoplasma near the electron cyclotron frequency. Meyer, R.L. (Nancy-1 Univ., 54 (France). Lab. de Physique des Milieux Ionises); Fidone, I. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee). *Phys. Lett., A;* **61**: No. 5, 321-322(30 May 1977).

The full dispersion relation of a warm magnetoplasma is numerically resolved with regard to Tokamak plasma heating.

11193 Ohmic heating in the W VII A-stellarator. Blaumoser, M.; Cattanei, G.; Cavallo, A. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)) (and others). pp 81-92 of In Plasma physics and controlled nuclear fusion research 1976. Vienna; International Atomic Energy Agency (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

First results of experiments with Ohmic heating in the W VII A-stellarator are reported. At $B_0=2.5$T, a comparison of discharges with large (rotational transform$_0=0.23$) and small (rotational transform$_0=0.055$) rotational transform of the external helical field is made. In the parameter regime, nsub(e)$=5X10^{18}$-$6X10^{19}$m^{-3}, Tsub(e)=200-900eV, Tsub(i)=100-220eV, energy confinement and MHD-instabilities are investigated. The energy density nT follows the scaling nT approximately rotational transform Jsub(p)B_0 (Jsub(p)=plasma current, B_0=toroidal field), the energy confinement time increases with nsub(e) and Tsub(e). Disruptive instabilities do not occur in discharges with large helical fields (rotational transform$_0=0.23$). Gas puffing during the discharge leads to higher densities (nsub(e)$_0$ approximately $8X10^{19}$m^{-3}), low Zsub(eff) and heating of the ions. Internal relaxations are not only observed on X-ray signals but also on various other diagnostic signals outside the plasma.

11194 Counterstreaming-ion tokamak fusion reactors. Jassby, D.L.; Kulsrud, R.M.; Perkins, F.W. (Princeton Univ., N.J. (USA). Plasma Physics Lab.); Killeen, J.; Marx, K.D.; McCoy, M.G.; Mirin, A.A.; Rensink, M.E.; Tull, C.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). pp 435-449 of In Plasma physics and controlled nuclear fusion research 1976. Vienna; International Atomic Energy Agency (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

Tokamak plasmas fuelled and heated by energetic neutral-atom beams are characterized by total ion pressure greatly exceeding the electron pressure. For smaller devices with relatively low injection energy, the largest fusion reactivity of energetic-ion plasmas is obtained when oppositely injected D^0 and T^0 beams sustain large densities of counterstreaming deuterons and tritons (CIT mode). In this study, steady-state ion velocity distributions for the CIT are calculated with a multispecies Fokker-Planck code, and are found to have sufficient thermal spread so that all infinite-medium velocity-space modes are stable. Quasistationary operation seems physically realizable, because the injected beams provide all fuelling, and the counterstreaming ions can be made to carry the bulk of the plasma current required for equilibrium; a satisfactory magnetic flux-surface configuration is revealed by a particle simulation code. Steady-state radial profiles of plasma parameters are determined with a coupled Fokker-Planck/radial transport code that includes charge-exchange effects and particle and heat diffusion of "warm" ions and electrons. With inclusion of realistic charge-exchange loss and a significant warm-ion population, the ideal CIT Q-values are found to be reduced by 60-70% for a given (nsub(e)tausub(Ee)). For example, Q=1.0 for Wsub(inj)=80keV(D^0) and 120keV(T^0), when (nsub(e)tausub(Ee))$=8X10^{13}$cm^{-3}s and (nsub(hot)/nsub(e)) approximately 0.7. Generally, the total ion pressure is 3 to 5 times the electron pressure, and the warm-ion temperature approximately 2Tsub(e).

11195 Multipulse heating of laser-produced plasmas in magnetic fields. Lengyel, L.L. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). pp 577-587 of In Plasma physics and cotrolled nuclear fusion research 1976. Vienna; International Atomic Energy Agency (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

The heating and ionization of large solid pellets by single and double laser pulses is considered. It is shown that ionization by a single pulse requires rather long pulses. The bulk ionization degree can be increased by applying composite pulse either of the same wavelength or of different wavelengths. The first pulse is to reduce the pellet density to values close to the cutoff value and to produce a number of electrons sufficiently high to accommodate efficient absorption during the second pulse; the second pulse is meant to heat and fully ionize the pellet. Optimum pulse combinations are found

for a spherically irradiated pellet 300μm in diameter. The effects of toroidal magnetic fields on laser-produced plasmas are discussed with particular regard to the β approximately 1 deceleration and the β much <1 toroidal expansion phases.

11196 Propagation of a trapped laser beam in a plasma column. Chapman, J.M. Seattle; Univ. of Washington (1977). 82p. University Microfilms Order No. 77-18,322.

Thesis (Ph. D.).

The propagation of an axisymmetric laser beam in a plasma column having a radially parabolic electron density distribution is examined. An extended paraxial procedure is developed for the case of an axially uniform waveguide and some general features of paraxial beam propagation are examined for the case of axially varying waveguides. Laser-plasma coupling is examined for the case when laser heating generates a density distribution that is radially parabolic near the axis and when the energy absorbed over a focal length of the plasma lens is small.

11197 RF ion heating near the lower hybrid frequency. Sant Ram; Ansari, H. (Aligarh Muslim Univ. (India). Dept. of Physics); Babu Ram (Aligarh Muslim Univ. (India). Z.H. Coll. of Engineering and Technology). *Indian J. Phys.;* **50**: No. 11, 956-958(Nov 1976).

It is shown that in a hot plasma, a slow wave approaching the hybrid layer is strongly damped by ion Landau damping. Wave absorption near the lower hybrid frequency is considered.

11198 Analysis of a slender solenoid plasma during thermonuclear burn. Willenberg, H.J. Seattle; Univ. of Washington (1976). 213p. University Microfilms Order No. 77-18,443.

Thesis (Ph. D.).

The development of a slender solenoid plasma and its associated alpha particles are analyzed during thermonuclear burn. Radially nonuniform plasma motion and heating is analyzed in a manner which is self-consistent with analysis of fusion-produced alpha particles travelling in orbits of comparable size to the plasma radius. A new numerical technique is presented which describes the development of magnetically-confined fusion products. This new technique represents the state of the alpha particles in terms of their population density distributed among their possible orbits. The plasma fluid equations and the alpha particle Boltzmann equation are numerically computed in a self-consistent manner in the APEBURP computer code, which was developed for this study. This code is applied to a variety of fast solenoid and steady solenoid plasmas for several milliseconds following thermonuclear ignition. The results are presented here. The fast solenoid configuration is shown to result in greater energy gain than the steady solenoid. The greatest gain is shown for plasmas with initial temperatures of 5 to 7 keV, and radius greater than 0.5 cm. The effect of very rapid alpha thermalization or anomalous radial diffusion is shown to be less efficient heating of the plasma, and therefore smaller energy gain.

PLASMA DIAGNOSTICS

11199 (EUR-CEA-FC—835) **Transition probabilities for argon I.** Katsonis, K.; Drawin, H.W. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee). Aug 1976. 135p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Transition probabilities for ArI lines have been calculated on the basis of the (j,k)-coupling scheme for more than 16000 spectral lines belonging to the transition arrays 4s-np (n=4 to n=9), 5s-np (n=5 to n=9), 6s-np (n=6 to n=9), 7s-np (n=8 to n=9), 4p-ns (n=5 to n=10), 5p-ns (n=6 to n=9), 6p-ns (n=7 to n=8), 4p-nd (n=3 to n=9), 5p-nd (n=4 to n=9), 3d-np (n=5 to n=9), 4d-np (n=6 to n=9), 5d-np (n=7 to n=9), 3d-nf (n=4 to n=9), 4d-nf (n=4 to n=9), 5d-nf (n=5 to n=9), 4f-nd (n=5 to n=9) 5f-nd (n=6 to n=9), 4f-ng (n=5 to n=9), 5f-ng (n=6 to n=9). Inso far as values by other authors exist, comparison is made with these values. It turns out that the results obtained in (j,k)-coupling are close to those obtained in intermediate coupling except for intercombination lines. For high principal and/or orbital quantum numbers the transition probabilities for a multiplet approach those of the corresponding transitions in atomic hydrogen. The calculated values are applied to construct a simplified argon-atom model, which reflects the real transition properties and which allows simplified but realistic non-equilibrium calculations for argon plasmas which deviate from local thermodynamic equilibrium (LTE).

11200 (EUR-CEA-FC—836) **Electron temperature and Zsub(eff) measurements in hot plasmas by soft x-ray analysis.** (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Feb 1977. 29p. Dep. NTIS (US Sales Only), PC A03/MF A01.

A hot plasma can be analyzed by means of the soft X-ray fluxes using various absorbers. In the first part, the method of calculation of the flux as a function of Tsub(e), Zsub(eff), nsub(e) and their profiles is given. The problem of relativistic corrections on the evaluation of the Gaunt factor is also considered. As an example, in a discharge at 200kA in T.F.R., the measured fluxes are compared to those calculated for a maxwellian electron distribution function. From this comparison the electron temperature is determined and information on the impurity content in the plasma is obtained, in agreement with other independent measurements.

11201 (EUR-CEA-FC—865) **Development of a data acquisition unit intended for pulsed plasma measurements.** Moulin, B. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee). Dec 1976. 132p. (In French). Dep. NTIS (US Sales Only), PC A07/MF A01.

A system suitable for the acquisition of the signals from measuring devices implanted in Petula and Wega is described. The technical specifications of the data acquisition system are discussed together with the results obtained.

11202 (EUR-CEA-FC—878) **Scattering of radiation from cyclotron harmonic oscillators.** Robinson, L.C.; Hewitt, R.G.L. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Groupe de Recherches sur la Fusion Controlee). Jan 1977. 13p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The cross-section for scattering of electromagnetic radiation from cyclotron harmonic oscillators in a high temperature plasma is calculated. The mechanism involves the absorption at one harmonic frequency and observation of the enhanced emission at nearby harmonic frequencies. If the harmonic line shapes are observed with a frequency-swept detector the magnetic field within a specified volume of the plasma can be determined. The experiment will also yield the electron temperature and density within this volume.

11203 Probe diagnostics of an rf plasma. Godyak, V.A.; Popov, O.A. (Physics Department, M. V. Lomnosov Moscow State University). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 4, 461-464(Apr 1977).

The effect of rf power on the accuracy of probe measurements is studied. Two methods are proposed for correcting probe measurements in the plasma of an rf discharge.

11204 Accuracy of plasma displacement measurement in a tokamak using magnetic probes. Ogata, A.; Aikawa, H.; Suzuki, Y. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Jpn. J. Appl. Phys.;* **16**: No. 1, 185-186(Jan 1977).

11205 Fast ion diagnostic experiment on ATC: radially resolved measurements of q, Z/sub eff/, T/sub ill/ and T/sub i/ . Goldston, R.J. Princeton, NJ; Princeton Univ. (1977). 215p. University Microfilms Order No. 77-19,173.

Thesis (Ph. D.).

The results are presented of three experiments investigating the behavior of supra-thermal ions in Tokamak discharges, and exploiting their potential for diagnostics. The theory governing collisionless ion orbits and governing the slowing down and scattering process is examined. Comparing this theory with neutral injection ion heating experiments and fast ion slowing-down measurements on ATC, one finds excellent agreement. A tightly collimated neutral beam was mounted on ATC to deposit fast ions concentrated at a chosen minor radius, and also a multi-sight-line charge-exchange detector to view the circulating fast ions. By examining the shift of the ion orbits from the Tokamak magnetic surfaces, one was able to deduce q = rB/sub T//RB/sub P/ on axis. In a second experiment, the scattering rate of fast ions was examined as a function of minor radius, to measure Z/sub eff/(r), and it was shown that it was sufficiently peaked on axis to explain this discrepancy. The radially averaged Z/sub eff/ deduced from the scattering rate was in good agreement with Z/sub eff/ deduced from the conductivity measurement, and the slowing down spectra were in detailed agreement with classical theory. The classical charge-exchange determination of ion temperature was performed by measuring the energy spectrum of fast neutrals emitted from the plasma. In this case the detector was aimed tangentially, and the outer half of the plasma column was scanned.

11206 Electron temperature measurement in JIPP-Ib stellarator by the method of time history. Ohasa, K.; Sato, K.; Kawahata, K.; Miyamoto, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). *Jpn. J. Appl. Phys.;* **15**: No. 12, 2403-2408(Dec 1976).

The time variation of the line emission of the impurities in the vacuum-ultraviolet spectral range is measured. With the use of experimental data, the electron temperature of the low β plasma confined in JIPP-Ib stellarator has been determined by the method of time history. The helium plasma produced by the ohmically heating current is used. The determined electron temperature is around 120 eV at 0.8 ms after the start of discharge. The results of the simulation based on the model introducing the effect of inhomo-

geneity show that the electron temperature determined by this method corresponds to the temperature at the plasma center.

11207 Comparison of probe and spectroscopic electron temperature measurements in a h.f. hydrogen plasma. Gupta, D.R. (Jodhpur Univ. (India). Dept. of Physics). *Indian J. Phys.;* **50**: No. 11, 990-992(Nov 1976).

11208 Interaction of laser and plasma investigated by scattering of light. Mizui, J.I.; Yamaguchi, N. (Nagoya Univ. (Japan). Inst. of Plasma Physics); Kang, H.B.; Sasaki, T.; Yoshida, K. *J. Phys. Soc. Jpn.;* **41**: No. 4, 1334-1338(Oct 1976).

The scattered light around the wavelength of the incident laser and its second harmonic was observed experimentally from the laser produced plasma. The experimental data can be understood consistently by the following model that the second harmonic is produced at the resonance (cut off) region, while the fundamental light is reflected from the turning (before cut-off) region. In the former region, the parametric process produces the large amplitude ion wave, which induces the Brillouin scattering. In the latter region the spectrum broadening of the reflected light is introduced by the self-phase modulation due to the temporal change of the plasma density.

PLASMA KINETICS - GENERAL

11209 (CONF-7605161—, pp 16-24) **Fusion and solar energy: potential alternative energy sources.** Kemeny, L.G. 1976.

From Annual engineering conference; Townsville, Australia (10 May 1976).

In Engineering, 1976—2001.

The present status and future prospects of fusion and solar energy sources are critically reviewed in terms of technology and economic prospects. In the case of thermonuclear fusion, the technology of magnetically and inertially confined fusion systems is discussed and future prospects for successful power generation are assessed. Consideration is given to the possible hybrid combination of fusion and fission systems. While conclusions concerning economic power generation are bound to be somewhat speculative, it is estimated that fusion techniques are unlikely to be competitive with fast breeder reactor systems before the end of the century unless the cost of superconducting magnets can be reduced by a factor of twenty to thirty. For inertial confinement systems this "break even" figure with fission technology will come when laser efficiencies of 20% and greater are achieved and when the ratio of fusion energy released to incident laser light is at least 30. The potential utilization of the solar energy source through biological and photochemical conversion is reviewed. Despite the many appealing aspects of solar energy conversion cycles, it is projected that by the year 2000 it will be providing the world with less than 10% of its solid liquid and gaseous fuel requirements.

11210 (INDC(NDS)—82/GB) **IAEA advisory group meeting on atomic and molecular data for fusion, Culham Laboratory, UK, 1—5 November 1976. Summary report.** Lorenz, A. (ed.). (International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee). Feb 1977. 75p. Dep. NTIS (US Sales Only), PC A04/MF A01.

The IAEA Nuclear Data Section convened an Advisory Group Meeting on Atomic and Molecular Data for Fusion at the UKAEA Laboratory at Culham, from 1-5 November 1976. Three detailed working group reports identifying requirements and availability of atomic collision data, atomic structure data, and surface interaction data in fusion research are presented. The meeting recommended the formation of an international network of data centres for the compilation and dissemination of atomic and molecular data required for fusion, and recommended that the IAEA Nuclear Data Section be given the responsibility to establish and coordinate this network.

11211 (UCRL—79953) **Relaxation of neodymium in a weakly ionized expanding plasma.** Chen, H.L.; Bedford, R.; Borzileri, C.; Brunner, W.; Hayes, M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Jun 1977. Contract W-7405-ENG-48. 23p. (CONF-771041—1). Dep. NTIS, PC A02/MF A01.

From 13. annual gaseous electronic conference; Stanford, California, USA (18 Oct 1977).

The laser resonance absorption technique has been used to determine the relaxation rate of electronically excited neodymium vapor during its expansion into vacuum. Significant increases of population into ground and 1128 cm^{-1} levels were found. Analysis shows that interaction between excited metastable atoms and electrons are much more important for relaxation than atom-atom collisions. The final population of neodymium appears to be frozen at a temperature lower than the surface temperature of melt.

11212 Effect of the rotating plasma column on the radiation due to the source of electric currents. Sharma, S.C.; Verma, J.S. (Birla Inst. of Tech. and Science, Pilani (India). Dept. of Physics). *Indian J. Phys.;* **50**: No. 11, 952-955(Nov 1976).

The effect of the rotating dielectric property of the plasma on the radiation pattern has been discussed. It can be pointed out that the plasma column (cylindrical shaped) while excited with the help of electric ring source gives more radiations for higher modes.

11213 Steady current generation by RF travelling field in a magnetized toroidal plasma. Fukuda, M.; Matsuura, K.; Hirano, K.; Mohri, A. (Nagoya Univ. (Japan). Inst. of Plasma Physics); Fukao, M. *J. Phys. Soc. Jpn.;* **41**: No. 4, 1376-1381(Oct 1976).

There are two factors to control the currents driven by RF fields travelling along a toroidal plasma; one is the penetration depth of the RF magnetic field into the plasma, and the other is the ratio of the RF magnetic field to the static toroidal magnetic field Bsub(t). The currents are observed to increase with Bsub(t), since the skin depth for the RF fields increases. There is an optimum toroidal magnetic field to hold a maximum toroidal current, and at higher Bsub(t), the toroidal currents decrease as more strongly than Bsub(t)sup(-1). The toroidal current can also be excited by a local assembly of RF coils.

PLASMA KINETICS - EXPERIMENTAL

REFER ALSO TO CITATION(S) 10296, 10297, 10299, 10300

11214 (CONF-760646—, pp 8-23) **Emission mechanism in high current hollow cathode arcs.** Krishnan, M. Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

Large (2 cm-diameter) hollow cathodes have been operated in a magnetoplasmadynamic (MPD) arc over wide ranges of current (0.25 to 17 kA) and mass flow (10^{-3} to 8 g/sec), with orifice current densities and mass fluxes encompassing those encountered in low current steady-state hollow cathode arcs. Detailed cathode interior measurements of current and potential distributions show that maximum current penetration into the cathode is about one diameter axially upstream from the tip, with peak inner surface current attachment up to one cathode diameter upstream of the tip. The spontaneous attachment of peak current upstream of the cathode tip is suggested as a criterion for characteristic hollow cathode operation. This empirical criterion is verified by experiment.

11215 Control of plasma potential distribution with an electron emissive limiter in a Q-machine. Hioki, Y. (Daido Inst. of Tech., Nagoya (Japan)); Okuda, T. *Jpn. J. Appl. Phys.;* **16**: No. 1, 211-212(Jan 1977).

11216 Formation of a hollow current profile in the early stages of the tokamak LT-3. Hutchinson, I.H. (Australian National Univ., Canberra. Research School of Physical Sciences). pp 227-236 of In Plasma physics and controlled nuclear fusion research 1976. Vienna; IAEA (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

CONF-761012—.

Experimental investigations of the ionization stages of the tokamak LT-3, using internal magnetic probes, reveal the formation of a hollow, skin-like current profile. During this period, Langmuir probe observations indicate that the electron density is strongly peaked on axis. The toroidal electric field is approximately uniform across the discharge, however, and thus the current profile arises from a proportional variation in conductivity, not from the classical skin effect. A theoretical model is described, based on the electron energy balance between the Ohmic heating input and the loss due to inelastic collisions with neutral particles, present during ionization. The model predicts a distinct maximum in the conductivity as a function of ionization degree at a given value of E/p. For an electron density peaked on axis such a variation leads to a current profile at first peaked on axis and then evolving into a hollow distribution. There is generally very good agreement between the model and the experimental observations. The most serious discrepancy is the peak conductivity temperature, which is observed to be higher than predicted. The effects of thermal conduction may account for this discrepancy.

PLASMA KINETICS - THEORETICAL

REFER ALSO TO CITATION(S) 10294

11217 (CONF-760646—) **Partially ionized plasmas including the third symposium on uranium plasmas.** Krishnan, M. (ed.). (National Aeronautics and Space Administration, Washington, D.C. (USA)). Sep 1976. 294p.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

Separate abstracts are included for 28 papers on electrically generated plasmas, fission generated plasmas, nuclear pumped lasers, gaseous fuel reactor research, and applications. Five papers have been previously abstracted and included in ERA.

11218 (CONF-760646—, pp 48-51) **Efficient procedure for computing partial ionization of a gas in numerical fluid dynamics.** Garribba, S. (Politecnico di Milan); Quartapelle, L. Sep 1976.

From Symposium on uranium plasmas; Princeton, New Jersey, USA (10 Jun 1976).

In Partially ionized plasmas including the third symposium on uranium plasmas.

A numerical procedure is described that for the first time allows efficient solution for the three nonlinear and implicit educations of state relating the equilibrium properties of a partially (and singly) ionized neutral gas. Energy, pressure and Saha's equations are encountered when solving the conservation laws of fluid dynamics. In the computation, the values for the intensive variables, that is pressure, temperature and ionization coefficient, are iteratively obtained with a given accuracy starting from assigned values for energy and volume per unit mass. Iterative computation is performed only when the value for the ionization coefficient lies within the lower and the upper bounds fixed by the required number of significant digits; otherwise the two explicit equations of state for nonionized or for fully ionized gases are employed. This procedure has been applied to the study of partial ionization produced in one-dimensional propagation of strong shock waves in hydrogen gas. The peaked shape of the density ratio vs. shock strength is clearly shown. The same procedure would also be easily applicable to steady or unsteady multidimensional flows where nonuniform ionization plays a substantial role.

11219 (EFI—189(35)-76) **Polarization losses of a relativistic charged particle in plasma located in strong high frequency electric field.** Amatuni, A.Ts.; Magomedov, M.R.; Sekhposyan, Eh.V.; Ehlbakyan, S.S. (Erevanskij Fizicheskij Inst. (USSR)). 1976. 10p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

Polarization losses of a charged particle passing through a plasma in homogeneous high frequency electric field are considered. It is shown that due to the variation of plasma dispersion in the external field, the terms appear in the expression for polarization losses which depend on the energy of the particle and the reaching of ionization loss plateau with the increase of frequency takes place at higher energies.

11220 (EUR-CEA-FC—879) **Impurity diffusion in Tokamaks in mixed regimes.** Rolland, P. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service d'Ionique Generale). Jan 1977. 8p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The particle diffusion in the mixed regime where the heavy impurities are in the Pfirsch-Schluter regime and the light ions are in the plateau regime is studied. It is shown that the formula of the intermediate Pfirsch-Schluter regime is recovered when tested by projection upon the exact solutions. The problem of nuclear shapes and band crossing is discussed either from the point of view of projecting particular intrinsic states on the exact solutions or from the quadrupole moment values of excited states. The results demonstrate the importance of angular momentum alignment in the nuclear the failure of determinantal approximations of the yrast line states and the.

11221 (ORNL/TM—5803) **Energy transfer from ions to electrons and the Coulomb logarithm.** McNally, J.R. Jr. (Oak Ridge National Lab., Tenn. (USA)). Sep 1977. Contract W-7405-ENG-26. 20p. Dep. NTIS, PC A02/MF A01.

Application of Chandrasekhar's stellar approach to plasmas reveals the importance of nondominant terms in both the energy transfer from ions to electrons and the form of the Coulomb logarithm. Curves illustrate the role of dominant and nondominant terms in the neighborhood of v/sub e/ approximately v/sub i/.

11222 (UCID—17516) **Stable propagation of a high-current electron beam: experimental observations and computational modeling.** Briggs, R.; Clark, J.; Fessenden, T.; Lee, E.; Lauer, E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Aug 1977. Contract W-7405-ENG-48. 22p. Dep. NTIS, PC A02/MF A01.

Experimental studies of self-focused, high-current electron-beam propagation phenomena are compared with the results of computational modeling. The model includes the radial structure of the beam-plasma system, a full electromagnetic field description, primary and secondary gas ionization processes, and a linear theory of the hose-like distortions. Good agreement between the experimental results and the computations strengthens the premise that hose instability is the principal limitation to propagation at high pressure.

11223 (UCID—17550) **EDOT: a code to calculate charge particle slowing down in a plasma.** Perkins, S.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Aug 1977. Contract W-7405-ENG-48. 39p. Dep. NTIS, PC A03/MF A01.

EDOT is a code that calculates the slowing down of a test particle in a Maxwellian plasma utilizing continuous slowing down theory. Both nuclear scattering and reactions are included. The output includes slowing down parameters as well as spectra of knock-on ions and in-flight reaction probabilities. The theory, input, and output for the code are described.

11224 (UCRL—80009) **Hybrid simulations of quasineutral phenomena in magnetized plasma.** Byers, J.A.; Cohen, B.I.; Condit, W.C.; Hanson, J.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Aug 1977. Contract W-7405-ENG-48. 10p. Dep. NTIS, PC A02/MF A01.

A new class of numerical algorithms for computer simulation of low frequency electromagnetic and electrostatic phenomena in magnetized plasma is presented. Maxwell's equations are solved in the limits of quasineutrality and negligible transverse displacement current (Darwin's model). Electrons are modeled as a fluid with polarization effects ignored. Ions are described as particles. A novel feature of these algorithms is the use of the electron fluid equation of motion to determine the electric field, which renders these numerical schemes remarkably simple and direct. The simulation plasma is either periodic or bounded by particle reflecting conducting walls. Both fully nonlinear codes with spatial grids and linearized gridless codes have been implemented.

11225 (UCRL—80119) **Equation of state of reacting strongly coupled plasmas.** Rogers, F.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Sep 1977. Contract W-7405-ENG-48. 12p. (CONF-770741—1). Dep. NTIS, PC A02/MF A01.

From NATO summer institute on coupled plasmas; Orleans, France (7 Jul 1977).

A brief review is given of the quantum statistical theory of strongly coupled many component reacting plasmas. It is shown that three distinct renormalizations of the many component activity series are required to obtain an expansion, which can properly handle strongly coupled reacting plasmas, for all states of ionization when $Z > 1$. Compensation between bound and scattering state contributions to the partition function is shown to be an important consideration and leads automatically to a convergent internal partition function.

11226 **Kinetic theory of a chemically reacting polyatomic plasma.** Saraf, J.R. (School of Physical Sciences, The New University of Ulster, Coleraine, Northern Ireland, United Kingdom). *Phys. Fluids;* **20**: No. 12, 2046-2048(Dec 1977).

A kinetic description is given for a polyatomic plasma consisting of electrons, ions, and atoms, the latter two species possessing internal degrees of freedom. The elastic, internal, and inelastic impact collisions have been modeled such that the system satisfies the conservation of charge, nuclei, mass, momentum, and translational plus rotational energy.

11227 **Accessibility of equilibria in an electron beam plasma system. II.** Cavalli, A.; Greenly, J.B.; Walsh, J.E. (Department of Physics and Astronomy, Dartmouth College, Hanover, New Hampshire 03755). *Phys. Fluids;* **20**: No. 12, 2088-2092(Dec 1977).

Equilibrium analysis of the long time evolution of an electron beam plasma system has demonstrated the accessibility of more than one stable equilibrium. Experimental observations indicate that the plasma finds each of these equilibria depending on the operating parameters and that therefore a knowledge of the overall equilibrium behavior is essential to a complete understanding of the evolution of the system.

11228 **Theory of the multiple potential well structure created by bipolar injection in spherical geometry.** Cherrington, B.E.; Swanson, D.A. (Gaseous Electronics Laboratory, Department of Electrical Engineering, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *Phys. Fluids;* **20**: No. 12, 2139-2144(Dec 1977).

A theoretical analysis has been performed on the potential structure formed when electrons and ions are injected into the interior of a sphere. The solution of Poisson's equation including spreads in the total energy and the angular energy of the injected particles has predicted a multiple potential structure very similar to that experimentally observed. The inclusion of trapped secondary electrons in the analysis also predicts a "triple-well" structure similar to that assumed to have been formed in Hirsch's original experiments.

11229 **Ray tracing in axisymmetric toroidal coordinates.** Gralnick, S.L.; Dalhed, H.E. (Princeton Plasma Physics Lab., NJ). *Nucl. Sci. Eng.;* **64**: No. 2, 373-378(Oct 1977).

A method is presented for determining the trajectory of a particle moving along a straight line orbit in axisymmetric toroidal coordinate systems. These geometries occur in problems associated

with neutral, neutron, and radiation transport studies in tokamak fusion devices. Numerical solutions of the equations describing the trajectory are performed in geometric configurations generated by the solution of the plasma equilibrium problem. An example problem of the deposition of a pencil beam of high-energy neutral particles in a tokamak plasma with a noncircular cross section due to the necessity of incorporating a divertor and the desirability of operating at a high plasma energy density is described.

11230 Charged particle energy deposition in an inertially confined thermonuclear plasma. Antal, M.J. (Princeton Univ., NJ); Lee, C.E. *Nucl. Sci. Eng.;* **64**: No. 2, 379-383(Oct 1977).

The transport equation governing the deposition of energy carried by fast charged particles in a thermonuclear plasma is derived and solved using a new discrete-ordinates method. This method is shown to be superior to a diffusion theory approximation. Excellent agreement with analytic results for a number of representative test problems has been obtained.

11231 Some properties of two-dimensional Coulomb system. Holz, A. (Freie Univ. Berlin (Germany, F.R.). Inst. fuer Theoretische Physik). *Phys. Lett., A;* **61**: No. 6, 399-401(13 Jun 1977).

It is shown that the phase diagram of a 2-dimensional Coulomb system shows a molecular gas plasma phase transition with a critical point on the temperature axis.

11232 Lifetime and level shift of bound states in plasmas. Kilimann, K. (Rostock Univ. (German Democratic Republic). Sektion Physik); Kraeft, W.D. (Ernst-Moritz-Arndt-Univ., Greifswald (German Democratic Republic)); Kremp, D. (Sektion Mathematik/Physik der Paedagogischen Hochschule 'Liselotte Herrmann', Guestrow, DDR). *Phys. Lett., A;* **61**: No. 6, 393-395(13 Jun 1977).

The complex poles of the two particle Green's function are investigated which describe the properties of two particle bound states with respect to a dynamically screened potential.

11233 Current generation in the interaction of a beam of accelerated multiply charged ions with a plasma. Gurevich, A.V. (P. N. Lebedev Physics Institute). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 10, 441-444(20 May 1977).

It is shown that when a compensated beam of fast Z-ions is decelerated in a plasma, a strong electric current is produced and can be Z times larger than the current of the multiply charged ions.

11234 Effects of an external magnetic field on discrete-particle processes in a plasma. Edward, J. New York; City Univ. of New York (1977). 154p. University Microfilms Order No. 77-13,674. Thesis (Ph. D.).

The inclusion of an external magnetic field in the microscopic description of a plasma is investigated. This inclusion becomes necessary when the magnetic field is strong enough for the thermal gyro-radius to be less than the Debye length. This particular ordering of the length parameters of a plasma is investigated in both two and three-dimensional systems. It is found that the appropriate kinetic equation for such an ordering is the Fokker-Planck equation since the magnetic field acts to screen the coulomb potential in isolated two-body interactions. The equations of motion of two isolated charged particles interacting electrostatically in the presence of an external magnetic field are studied from a numerical and analytic viewpoint. It is found that there is a difference in the way the two particles interact, depending on whether or not their gyro-radii overlap. Collisions with overlapping gyro-radii are found to be very much like unmagnetized collisions, resulting in significant kinetic energy transfer. Collisions with gyro-radii which do not overlap, are found not to involve significant kinetic energy transfer, due to the fact that the magnetic field has an important effect on the interaction process. The magnetic field acts to screen the coulomb potential, so that there are two distinct types of binary collisions in a strongly magnetized plasma. These ideas are used to study the kinetic theory of a two-dimensional strongly magnetized plasma in the Fokker-Planck limit. In these calculations the magnetic field is included in the collision integrals of the system. These collision integrals are then used to serve as the basis for a Chapman-Enskog calculation of collisional transport coefficients. It is found that collisional transport is much smaller than collective transport in a two-dimensional plasma.

11235 Stimulated Compton scattering in a plasma. I. Long-time-interval behaviour of the wave spectrum and the electron temperature. Reinisch, G. (Laboratoire de Physique de la Matiere Condensee, (Associe au CNRS, no 190), Nice, France). *Physica, B, C;* **81**: No. 2, 339-350(Feb 1976).

A first approximation study of the self-consistent kinetics of a closed system constituted by a gas of photons and a homogeneous, infinite, isothermal gas of free maxwellian electrons is performed assuming the validity of the Kompaneets differential kinetic equations (this validity is discussed). A quasi-asymptotic study (for long time intervals) of the system of kinetic equations describing both the evolution of the spectrum and the related variation of the electron temperature Tsub(e) is then developed. It is shown that the kinetic equation of the photons simplifies into a Burgers-type equation with a small diffusive coefficient: as a consequence, a triangular spectral profile is obtained, which extends toward the red frequencies according to a tsup(1/2)-law, while Tsub(e) increases in the same way. The importance of the linear-induced term γ^{-2}(delta/deltaγ)γ^{4}(delta/deltaγ)sup(n) in the photon kinetic equation (the only one to be related to Tsub(e)). This term was usually neglected in all quantitative studies of the stimulated (Tsub(B)>>Tsub(e)) Compton scattering in a plasma. As an application, the possibility of the onset of an equilibrium situation with a Planckian distribution is investigated. This leads to the conclusion that such an equilibrium state is available only for systems having a sufficiently high number of photons. The threshold value for this number of photons is found.

11236 Calculation of transport coefficients in an axisymmetric plasma. Shumaker, D.E. Davis, CA; Univ. of California (1976). 270p. University Microfilms Order No. 77-14,008.

Thesis (Ph. D.).

A method of calculating the transport coefficient in an axisymmetric toroidal plasma is presented. This method is useful in calculating the transport coefficients in a Tokamak plasma confinement device. The particle density and temperature are shown to be a constant on a magnetic flux surface. Transport equations are given for the total particle flux and total energy flux crossing a closed toroidal surface. Also transport equations are given for the toroidal magnetic flux. A computer code was written to calculate the transport coefficients for a three species plasma, electrons and two species of ions. This is useful for calculating the transport coefficients of a plasma which contains impurities. It was found that the particle and energy transport coefficients are increased by a large amount, and the transport coefficients for the toroidal magnetic field are reduced by a small amount. For example, a deuterium plasma with 1.3 percent oxygen, one of the particle transport coefficients is increased by a factor of about four. The transport coefficients for the toroidal magnetic flux are reduced by about 20 percent. The increase in the particle transport coefficient is due to the collisional scattering of the deuterons by the heavy oxygen ions which is larger than the deuteron electron scattering, the normal process for particle transport in a two species plasma. The reduction in the toroidal magnetic flux transport coefficients are left unexplained.

11237 Physics, fluid, and plasma. Ceperley, D.M. Ithaca, NY; Cornell Univ. (1976). 133p. University Microfilms Order No. 77-18,862.

Thesis (Ph. D.).

The first part of this thesis deals with the classical one component plasma. The two particle correlation function for the classical one component plasma in the high density fluid phase is calculated from the correlation function of a short range reference potential by a perturbation method based on the hypernetted chain equation (HNC). It is shown that the long wavelength correlations are correctly described by this method. A technique for extending g(r) to infinity is shown to be valid and useful. The results are in excellent agreement with those obtained from the "Enwald image" Monte Carlo method. The remainder of this thesis is concerned with the ground state of quantum systems. The Metropolis Monte Carlo method is used to sample an antisymmetric wavefunction composed of a product of a Jastrow wavefunction and a Slater determinant. Variational energies are calculated for helium 3 and several models of neutron matter. Also the spin-dependent correlation functions and the momentum distribution are computed. The first order Wu-Feenberg expansion is shown always to underestimate the energy, sometimes seriously. The phase diagram for ground state Yukawa matter is determined and an estimate of crystallization density of the "Wigner solid" is obtained, r/sub s/ = 56.

PLASMA PRODUCTION

11238 Observation of fast ions in a laser plasma. Zakharenkov, Y.A.; Krokhin, O.N.; Sklizkov, G.V.; Shikanov, A.S. (P. N. Lebedev Physics Institute, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 9, 388-391(5 May 1977).

Experiments on heating of spherical targets wth the high-power "Kal'mar" laser installation revealed a group of fast ions with energy 9 or ≈0.5 MeV. The possible generation mechanisms are discussed.

PLASMA INSTABILITIES

REFER ALSO TO CITATION(S) 11222

11239 (CTH-IEFT/PP—1977-2) **Growth of modulational instability for randomized initial conditions.** Weiland, J. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden). Inst. for Electromagnetic Field Theory and Plasma Physics). 1977. 25p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The creation of density depletions due to purely growing modes in turbulent plasmas are studied in the self-consistent situation where there is no pumping. The basic equations, the self-consistent system of equations governing the modulational instability, are solved numerically.

11240 (CTH-IEFT/PP—1977-3) **Note on parametric interactions involving frequency modulated pumps.** Anderson, D.; Bondeson, A. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden). Inst. for Electromagnetic Field Theory and Plasma Physics). 1977. 7p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Some simple results are presented for the average growth-rate of parametric processes involving frequency modulated pumps. A comparison with the case of random pump phase modulation is also made.

11241 (EUR-CEA-FC—874) **Weakly turbulent kinetic theory of the electromagnetic ion-cyclotron instability. Initial noise and quiet start (Q.S.) in electromagnetic particle simulation codes.** Sternlieb, A. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee). Jan 1977. 25p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The parallel propagation of electromagnetic ion-cyclotron waves in a multicomponent magnetized plasma is investigated via a weakly turbulent kinetic theory. A tendency appeared for iso-thermalization of the warm anisotropic components, a mass-dependent nonresonant heating of the cold components, and a gradual decrease in the unstable spectrum range. Fair agreement is found with computer simulation results. Some possible constrictive consequences concerning plasma heating and confinement in magnetic devices are mentioned. The results of applying first and second moment quiet start to simulation of electromagnetic ion-cyclotron instability are also presented. It is found that proper use of the method is necessary when accurate evaluations of growth rates with a relatively small number of simulation particles are desired. A reduction in the initial noise of more than two orders of magnitude is obtained.

11242 (INIS-mf—3821) **Effect of external growth-rate modulation on the nonlinear mode coupling between stable and unstable plasma waves.** Anderson, D.; Bondeson, A. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden). Inst. for Electromagnetic Field Theory and Plasma Physics). 1976. 14p. Dep. NTIS (US Sales Only), PC A02/MF A01.

External growth-rate modulation of a linearly unstable plasma wave, saturated by nonlinear Landau damping may introduce parametric amplification. The threshold, growth-rate and final saturation level for this instability are determined.

11243 (INIS-mf—3822) **Effect of growth-rate modulation on the nonlinear mode coupling between stable and unstable plasma waves.** Anderson, D.; Bondeson, A.; Falk, L. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden). Inst. for Electromagnetic Field Theory and Plasma Physics). 1976. 21p. Dep. NTIS (US Sales Only), PC A02/MF A01.

An investigation is made of the effect of an external growth-rate modulation on the saturation of a linearly unstable plasma wave by means of nonlinear Landau damping. Different ways of exciting the saturated system by suitable choices of modulation frequency are discussed and the characteristics of the resulting instabilities, like thresholds, growth-rates, maximum amplitudes and final saturation levels are determined.

11244 (INIS-mf—3824) **Influence of stochastic mismatch on the parametric excitation of coupled modes.** Bondeson, A. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden). Inst. for Electromagnetic Field Theory and Plasma Physics). 1976. 14p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The influence of stochastic mismatch on a system of two first-order parametrically coupled differential equations is studied. The effective growth rate for amplitudes and powers is calculated as a function of the nonrandom parameters of the system, i.e. unperturbed growth rate, damping and average mismatch, as well as of the statistic properties of the random mismatch.

11245 (INIS-mf—3825) **Effect of heat wave relaxation time on nonlinear Landau damping.** Anderson, D.; Bondeson, A. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden). Inst. for Electromagnetic Field Theory and Plasma Physics). 1976. 10p. Dep. NTIS (US Sales Only), PC A02/MF A01.

An investigation is made of the effect of finite beat wave damping on the relaxation oscillations associated with the saturation of plasma instabilities by means of nonlinear Landau damping.

11246 Quasi-linear and nonlinear theory of dissipative trapped particle instabilities. Ehst, D.A. (Applied Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Fluids;* **20**: No. 12, 2076-2087(Dec 1977).

An examination of particle linear orbits reveals how charged particles nonresonantly exchange energy with trapped particle modes in the presence of collisions. Phase space diffusion coefficients are constructed which describe the changes in the equilibrium particle distributions and which allow computation of the linear growth rates of the dissipative trapped particle instabilities. Wave-induced detrapping and resonance broadening are considered as nonlinear modifications of the particle-wave interaction and found to be ineffective as mechanisms to saturate growth of the dissipative trapped ion mode. Mode coupling with plasma diffusion across the magnetic field is a stronger effect for this and the dissipative trapped electron mode. Final evaluation of plasma diffusion coefficients is complicated by an ignorance of the nonlinear spectral shape.

11247 Saturation of the cyclotron decay instability. Sperling, J.L. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Fluids;* **20**: No. 12, 2104-2112(Dec 1977).

The cyclotron decay instability results from the nonlinear interaction of a magnetosonic wave with two electrostatic ion-cyclotron waves in a multispecies plasma. A saturation mechanism for the instability is the nonlinear ion-cyclotron damping process involving the interaction of electrostatic ion-cyclotron and hydromagnetic-acoustic turbulence with a nonlinear plasma response near an ion-cyclotron frequency. Strong nonlinear ion heating can be a consequence of the saturation particularly if electron Landau damping is reduced by quasi-linear diffusion or trapping.

11248 Collisional effects on trapped electron instabilities. Tsang, K.T.; Callen, J.D.; Catto, P.J. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Fluids;* **20**: No. 12, 2113-2120(Dec 1977).

The effects of collisions on dissipative trapped electron instabilities are evaluated by distinguishing between the perpendicular and parallel electron velocity components when calculating trapped and untrapped electron contributions. The growth rate is obtained for all regimes of collisionality and reduces to previous results in appropriate limits. It is shown that the dominant effect of finite collisionality is to determine the number of trapped and untrapped electrons and that collisional broadening removes the resonant electron response only for collision frequencies greater than or equal to ten times the wave frequency, $\nu/\mathrm{sub}\ e/> \text{ or } \approx 10\omega$. For such large $\nu/\mathrm{sub}\ e//\omega$, ion-ion collisions are found to exert a far stronger stabilizing influence than broadening.

11249 Effect of electron-ion collisions on the nonlinear state of the relativistic two-stream instability. Thode, L.E. (Theoretical Division, University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Fluids;* **20**: No. 12, 2121-2127(Dec 1977).

The analysis outlines conditions for the hydrodynamic interaction, including foil scattering and beam self-magnetic field effects. For the hydrodynamic interaction, the oblique coupling coefficient model is extended to include the effect of a finite electron-ion collision rate on the nonlinear state. Partial numerical simulation results are found to be in agreement with the model. Limitations due to temperature inhomogeneity along the deposition length and to increased deposition length are also discussed. It is found that an intense relativistic electron beam can couple its energy via the two-stream instability to a high density 10^{17}—10^{20} cm^{-3} plasma. It is required that the plasma be fully ionized, with an initial electron temperature of >10 eV for 10^{17} cm^{-3}, 10—20 eV for 10^{18} cm^{-3}, 15—50 eV for 10^{19} cm^{-3}, and ~ 100 eV for 10^{20} cm^{-3}.

11250 Finite-gyroradius stabilization of diffuse high beta stellarators. Freidberg, J.P.; Hewett, D.W. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Fluids;* **20**: No. 12, 2128-2138(Dec 1977).

A method is described for estimating the finite gyroradius stabilization of $m>$ or $=2$ magnetohydrodynamic modes in diffuse high-β stellarators. The procedure combines both analysis and numerical computation. In particular, the difficult trajectory integrals which arise in the formulation are evaluated by plasma simulation techniques. The method is successfully applied to the $m=2$ modes in the high-β, $l=1$ stellarator configuration. It is found that the stability criterion for diffuse profiles is somewhat more optimistic than earlier estimates based on the sharp boundary model.

11251 Anisotropic production of laser-plasma soft x rays and fast electrons from thin plastic targets. Violet, C.E.; Petruzzi, J. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Appl. Phys.;* **48**: No. 12, 4984-4990(Dec 1977).

In separate experiments incident pulses from two different Nd-glass lasers and a CO_2 laser were fired at planar targets of thin plastic, and the angular distributions of the soft x rays and fast electrons were measured. The focused power densities of the first Nd-glass laser and the CO_2 laser were 2×10^{12} W/mm^2, of the second Nd-glass laser, 2×10^{13} W/mm^2. The electron efficiency of the CO_2 laser plasmas is strongly peaked antiparallel to the incident pulse, the backward-to-forward ratio being 100. The electron effi-

ciency of both Nd-glass lasers is less than 150% of their x-ray efficiency. The x-ray efficiencies of the Nd-glass laser plasmas are at least an order of magnitude greater than that of the CO_2 laser plasmas. The x-ray efficiency of the first Nd-glass laser was isotropic. The x-ray distribution for both the second Nd-glass laser and the CO_2 laser plasmas had the backward-to-forward ratio of 4.

11252 Observation of anomalous resistivity caused by ion acoustic turbulence. Kawai, Y.; Guyot, M. (Centre de Recherches en Physique des Plasmas, Ecole Polytechnique Federale de Lausanne, CH-1007 Lausanne, Switzerland). *Phys. Rev. Lett.;* **39**: No. 18, 1141-1144(31 Oct 1977).

The dc resistivity caused by ion acoustic turbulence in plasmas is measured and effective collision frequencies of electrons are obtained from the resistivity as a function of electron drift velocity. These experimental results can be explained by using the theoretical model of Horton et al., in which the nonlinear ion Landau damping dominates the turbulence spectrum.

11253 Parametric excitation by a pump magnetic field in a high temperature plasma. Cramer, N.F. (Sydney Univ. (Australia). School of Physics). *Phys. Lett., A;* **61**: No. 5, 314-316(30 May 1977).

The parametric growth rates of Alfven waves, fast compressional waves and ion acoustic waves excited by a time modulated magnetic field are calculated for the case of a high temperature plasma with anisotropic pressure. The plasma is described by the C.G.L. model.

11254 Absolute and convective instabilities of electrostatic ion cyclotron waves excited in an ion beam-plasma system. Sugawa, M.; Sugaya, R.; Nomoto, H. (Ehime Univ., Matsuyama (Japan). Faculty of Science). *Phys. Lett., A;* **61**: No. 5, 323-325(30 May 1977).

Experimental results are presented for the observation of the absolute and convective instabilities of the electrostatic ion cyclotron waves excited in an ion beam-plasma system.

11255 Ion Larmor radius effects on the interchange instability in a sheared magnetic field. El-Nadi, A.M. (Bochum Univ. (Germany, F.R.). Inst. fuer Theoretische Physik); El-Sayed, Z.N. (Cairo Univ. (Egypt)). *Phys. Lett., A;* **61**: No. 4, 241-243(16 May 1977).

The localized interchange instability in a low β collisionless plasma is studied as an eigenvalue problem in the presence of magnetic shear. It is found that while shear is always stabilizing, the ion Larmor radius effects become destabilizing if the shear exceeds a certain value.

11256 Model of magnetic-field reconnection in a plane layer of collisionless plasma. Galeev, A.A.; Zelenyi, L.M. (Institute of Space Research, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **25**: No. 9, 380-384(5 May 1977).

We consider the instability of a plane plasma layer placed in a magnetic field with rotating force lines. The instability constitutes excitation of the kinetic tearing mode. The overlap of the modes that develop near different resonant surfaces causes stochastic diffusion and reconnection of the magnetic-field force lines. The proposed mechanism may ensure reconnection of the interplanetary and geomagnetic fields at the boundary of the earth's magnetosphere.

11257 Dynamic stabilization of the imploding shell Rayleigh-Taylor instability. Boris, J.P. *Comments Plasma Phys. Controlled Fusion;* **3**: No. 1, 1-13(Apr 1977).

A method for dynamic stabilization of the Rayleigh-Taylor (R-T) instability on the surface of an imploding fusion pellet is discussed. The driving laser beams are modulated in intensity so the ablation layer is subject to rapidly and strongly oscillating acceleration. A substantial band of the Rayleigh-Taylor instability spectrum can be stabilized by this oscillation even though the time average acceleration vector lies in the destabilizing direction. By adjusting the frequency, structure, and amplitude of the modulation, the band of dynamically stabilized modes can be made to include the most unstable and dangerous modes. Thus considerably higher aspect ratio shells (i.e. thinner shells) could implode successfully than had been previously considered stable enough. Both theory and numerical simulations support this conclusion for the case of laser-driven pellet implosions. Similar modulation via transverse beam oscillations or parallel bunching should also work to stabilize the most dangerous surface Rayleigh-Taylor modes in relativistic electron-, ion-and heavy-pellet fusion schemes.

11258 Dispersion and spectral characteristics of crossfield instability in collisional magnetoplasma. Saxena, Y.C.; John, P.I. (Physical Research Lab., Ahmedabad (India)). *Pramana;* **8**: No. 2, 123-132(Feb 1977).

Results on dispersion and spectral characteristics of crossfield instability in a collisional magnetoplasma are presented for different values of externally applied radial electric field. The dispersion relation obtained experimentally differs significantly from predictions of linear theory for strong electric fields. K-spectra for density and potential fluctuations follow power law with indices (-3.7 +- 0.5) and (-5.6 +- 0.6) respectively. At large values of applied electric fields, the main crossfield modes appear to give rise to a number of other modes possibly through non-linear wave-wave interactions. Large amplitude m = 2 mode displays strong sidebands indicating particle trapping by the non-linear waves. Non-linear wave-wave and wave particle interactions, thus, appear to play an important role in the saturation of the cross field instability.

11259 Experimental studies of explosive instability in an ion beam-plasma system. Nakamura, S. (Kyoto Univ. (Japan). School of Liberal Arts and Sciences). *J. Phys. Soc. Jpn.;* **42**: No. 1, 280-289(Jan 1977).

When the ion beam-plasma system is stimulated by a pump field with frequency f_0 near the ion Langmuir frequency f sub(pi), the ion sound wave (f sub(s)) is enhancedand, at the same time, a new wave (f sub(b)) corresponding to the slow wave of the beam appears, and among their frequencies, the resonant condition, f sub(b) = f sub(pi) + f sub(s), is satisfied. The resonant condition for the wave numbers, k sub(b) = k sub(pi) + k sub(s), is ascertained by a test wave method. The test wave grows temporally at the frequencies coinciding with the frequencies of f sub(b) and f sub(pi) and, at the same time, the wave with the frequency of f sub(b) -f sub(pi) = f sub(s) grows also temporally. Their growing is affected by an ion beam energy, an initial intensity of the pump field and its frequency. These phenomena will be discussed with a nonlinear theory of the explosive instability for the coherent three-wave interaction.

11260 Nonlinear drift wave in a collisionless nonuniform plasma. Sanuki, H. (Nagoya Univ. (Japan). Inst. of Plasma Physics); Schmidt, G. *J. Phys. Soc. Jpn.;* **42**: No. 1, 260-264(Jan 1977).

A nonlinear theory of the collisionless drift wave is developed in a planner geometry with an arbitrary one-dimensional density profile. An equation describing the potential variation in the direction of density gradient is derived. The dispersion relation and the corresponding waveform are obtained from solutions of an eigenvalue problem. A special density profile is analyzed in detail. It is shown that the drift wave is localized in the x-direction and also has a solitary wave structure in the y-z plane, which is described by a modified Korteweg-de Vries equation.

11261 Kink instabilities of a toroidal screw pinch. Wakatani, M. (Nagoya Univ. (Japan). Inst. of Plasma Physics). *J. Phys. Soc. Jpn.;* **42**: No. 1, 265-273(Jan 1977).

Kink instabilities in a screw pinch with a circular cross-section are studied in a toroidal geometry for βsub(p) -- epsilon sup(-1/2) and q(a) -- 1, where epsilon is an inverse aspect ratio and q(a) is a safety factor at a plasma surface r=a. The constant-pitch force-free field surrounding a main plasma improves MHD stability, compared with a high β tokamak. However, it is necessary to satisfy the Kruskal-Shafranov limit, in order to ensure stable discharges in the toroidal geometry.

11262 Axisymmetric instabilities of non-circular plasma cross-sections and computation of highly elongated tokamak equilibria. Becker, G.; Lackner, K. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). pp 401-409 of In Plasma physics and controlled nuclear fusion research 1976. Vienna; International Atomic Energy Agency (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

A code for testing numerically computed MHD equilibria for axisymmetric instabilities is used to study the effect of current distribution and aspect ratio for non-circular cross-sections produced by applied quadru-, hexa- and octupole fields. Peaked current distributions are found to have a significant stabilizing effect for triangular and higher-order deformations, which is stronger the more rapidly the multipole fields decay towards the plasma centre. In the second part, results of equilibrium computations for highly elongated plasma cross-sections are given. Whereas calculations with a code using a feedback scheme for the applied multipole currents give convergent results also for semiaxis ratios b/a approximately <14, iterations assuming fixed external currents fail to converge for b/a approximately <4.

11263 Linear and non-linear theory of trapped-particle instabilities. Tang, W.M.W.; Adam, J.C.; Cohen, B.I.; Frieman, E.A.; Rewoldt, G.; Rutherford, P.H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.); Krommes, J.A.; Rosenbluth, M.N. (Institute for Advanced Study, Princeton, N.J. (USA)); Ross, D.W. (Texas Univ., Austin (USA)); Catto, P.J. (Rochester Univ., N.Y. (USA)). pp 489-497 of In Plasma physics and controlled nuclear fusion research 1976. Vienna; International Atomic Energy Agency (1977).

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

See CONF-761012—.

This paper analyses several important features of trapped-particle instabilities. For trapped-electron modes, the complete two-

dimensional (2D) spatial structure, including the effects of magnetic shear, is numerically calculated within the framework of a differential formulation for long radial wavelength modes. Growth rates obtained for representative cases correlate reasonably well with the usual one-dimensional (1D) estimates of shear stabilization. However, the spatial structure of the mode differs markedly; e.g. it typically extends over several mode-rational surfaces. Specific collisional mechanisms affecting the linear stability of these modes are also studied. Collisional scattering of low-energy electrons can reduce the non-adiabatic trapped-electron response and collisional broadening can strongly modify the resonant response of the untrapped electrons. The saturation of the usual form of the dissipative trapped-ion instability by mode coupling is studied analytically and numerically. The "solitary wave" or "multi-mode" equilibria of LaQuey et al. are found to be unstable and inaccessible. However, their "two-mode" equilibria can be both stable and accessible and can lead to transport levels well below the Kadomtsev-Pogutse estimates, provided wave dispersion is small and the parameters considered are not far from marginal stability. In addition to the standard trapped-ion modes, which are associated with the electron diamagnetic drift branch, it is found that ion diamagnetic modes of this type can also be generated. This new branch is destabilized by both resonant and non-resonant interactions with ions which have average unfavourable magnetic drifts. If the ion temperature gradient parameter, etasub(i)-dlnTsub(i)/dlnn, is either large (etasub(i)>2/3) or negative (etasub(i)<0), growth rates from the ion branch are dominant over the electron branch.

PLASMA WAVE PHENOMENA

REFER ALSO TO CITATION(S) 11356

11264 (CTH-IEFT/PP—1977-1) **Evolution in space and time of two interacting intensities.** Wilhelmsson, H. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden). Inst. for Electromagnetic Field Theory and Plasma Physics). 1977. 17p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The basic nonlinear coupled equations describing the interaction between two intensities (or two populations) are discussed. Analytic solutions are deduced for the evolution in space and time of initially given perturbations of the equilibrium intensities.

11265 (CTH-IEFT/PP—1977-5) **Interaction between stable and unstable waves by nonlinear coupling to a quasimode.** Bondeson, A. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden). Inst. for Electromagnetic Field Theory and Plasma Physics). 1977. 9p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The steady state, in space and time, of a non-explosive-type three-wave interaction involving a linearly unstable pump and two damped decay modes, is studied. The stability of the steady state is investigated in the limit when one of the decay modes is heavily damped. Explicit criteria for absolute and convective instabilities are presented.

11266 (EUR-CEA-FC—864(Pts.1-2)) **Asymptotic method in the nonlinear theory of coherent Langmuir waves.** Trocheris, M. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Dec 1976. 37p. (In French). Dep. NTIS (US Sales Only), PC A03/MF A01.

The weakly nonlinear effects for coherent waves are considered in the Vlasov model and treated by the asymptotic method, the assumption of the simplest physical problem, i.e. that of the electronic plasma waves or Langmuir waves being made. In view of discarding any possible resonant interaction between waves and particles, the distribution functions are assumed to cancel outside an interval -V<v<V at any time t and the only possible waves are assumed to have phase velocities outside this interval. The final result is a system of equations relating to wave amplitudes, the coupling modes being described by quadratic terms.

11267 (INIS-mf—3823) **Normal modes and dispersive properties of plasma systems.** Weiland, J. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden). Inst. for Electromagnetic Field Theory and Plasma Physics). 1976. 16p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The description of nonlinear wave phenomena in terms of normal modes contra that of electric fields is discussed. The possibility of defining higher order normal modes is pointed out and the field energy is expressed in terms of the normal mode and the electric field.

11268 (INIS-mf—3826) **Stationary solutions of resonant nonlinear three wave interactions involving growing and damped waves.** Anderson, D.; Bondeson, A. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden). Inst. for Electromagnetic Field Theory and Plasma Physics). 1976. 10p. Dep. NTIS (US Sales Only), PC A02/MF A01.

An investigation is made of the existence and stability of stationary solutions of a system describing the resonant interaction between one linearly unstable pump wave and two damped decay waves. An explicit stability criterion is found as well as expressions for the steady state excitation levels.

11269 (INIS-mf—3827) **Wave energy in a beam plasma.** Kirk, J.; Weiland, J. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden). Inst. for Electromagnetic Field Theory and Plasma Physics). 1976. 8p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The question of the sign of the energy of the electrostatic wave which is excited in a beam plasma system is discussed. The relevance of this sign for the existence of an explosively unstable coupling to two positive energy waves is investigated. Weakly explosive instabilities are expected.

11270 (INIS-mf—3828) **Some remarks on coherent nonlinear coupling of waves in plasmas.** Wilhelmsson, H. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden). Inst. for Electromagnetic Field Theory and Plasma Physics). 1976. 15p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The analysis of nonlinear processes in plasma physics has given rise to a basic set of coupled equations. These equations describe the coherent nonlinear evolution of plasma waves. In this paper various possibilities of analysing these equations are discussed and inherent difficulties in the description of nonlinear interactions between different types of waves are pointed out. Specific examples of stimulated excitation of waves are considered. These are the parametric excitation of hybrid resonances in hot magnetized multi-ion component plasma and laser-plasma interactions.

11271 (KFTI—76-17) **Parametric excitation of potential waves in a cold inhomogeneous plasma.** Demchenko, V.V.; Omel'chenko, A.Ya. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1976. 22p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

Parametric excitation of potential waves in a cold inhomogeneous isotopic plasma has been investigated. It has been shown that the problem of the parametric resonance is divided in this case into "temporal" (parametric) and "spatial" parts. The "temporal" part, which determines frequencies and increments of enhancement of unstable oscillations coincides with a system of differential equations describing the parametric excitation of space waves in a homogeneous plasma. The value of the partition constant is found by solving an equation describing the "spatial" part of the problem, taking into account for specific boundary conditions. The method proposed is simpler than the conventional method used in the theory of parametric resonances in an inhomogeneous plasma.

11272 **Ion acoustic solitary waves in the presence of a high frequency electric field.** Satya, Y.S.; Goswami, B.N. (Physical Research Lab., Ahmedabad (India)). *Phys. Lett., A;* **61**: No. 6, 388-390(13 Jun 1977).

The propagation of a small but finite amplitude ion acoustic wave in the presence of a radio frequency (frequency below electron plasma frequency) electric field is investigated. The velocity, the amplitude and the width of the solitary wave are found to decrease with increasing intensity of the RF field.

11273 **Nonlinear ponderomotive force effects on plasma resonance cones.** Kuehl, H.H. (University of Southern California, Los Angeles (USA)). *Phys. Lett., A;* **61**: No. 4, 235-237(16 May 1977).

The nonlinear equation is derived governing the field on two-dimensional resonance cones in a plasma for all frequencies for which the resonance cones exist. This equation reduces to the modified Korteweg-de Vries equation only if the electric field is real.

11274 **Plasma absorption of electromagnetic waves above the lower hybrid frequency.** Anisimov, A.I.; Baranov, Y.F.; Bulyginskii, D.G.; Vinogradov, N.I.; Golant, V.E.; Dyatlov, Y.P.; Shustova, N.V. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 4, 458-460(Apr 1977).

The absorption of electromagnetic waves at frequencies above the lower hybrid frequency is studied in a plasma in a toroidal magnetic field. At a hydorgen pressure of the order of 10^{-3} torr absorption occurs in the outer part of discharge, apparently because of collisional absorption of a surface mode. At lower pressures, the plasma density is reduced by the rf wave. Mechanisms capable of explaining the observations are discussed.

11275 **Resonant emission of a magnetized plasma from an open plane periodic waveguide.** Gestrina, G.N.; Kobelev, V.N.; Shestopalov, V.P. (Institute of Radiophysics and Electronics, Academy of Sciences of the Ukrainian SSR, Khar'kov). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 4, 483-487(Apr 1977).

A theory is given for the anomalous extension of the diffraction field from a plane narrow-slit waveguide filled with a magnetized plasma and excited by a modulated electron beam. In the

limiting case in which the slits are covered, and the conditions correspond to resonance for the corresponding closed system, the fringing field has a definite polarization, and the radiated energy flux approaches a finite limit which is independent of the external magnetic field. Radiation maxima should be observed near the grazing angles.

11276 Self-consistent stationary density cavities with many bounded Langmuir waves. Mima, K. (Bell. Labs., Murray Hill, N.J. (USA)); Kato, K.; Nishikawa, K. *J. Phys. Soc. Jpn.;* **42**: No. 1, 290-296(Jan 1977).

Stationary one-dimensional propagation of Langmuir waves trapped in a local density cavity in a plasma is investigated for the case in which the frequency spectrum of the Langmuir waves is broad as compared with the ion acoustic frequency, but in which their wavenumbers are comparable to the inverse scale length of the density cavity. Analytical solutions for the density cavity, which traps many Langmuir wave modes and which is self-consistent with the ponderomotive potential coming from these eigenmodes, are obtained. The Langmuir wave envelopes exhibit oscillations at the beat frequencies of the different eigenmodes. These solutions are valid when the intensity of the trapped Langmuir waves normalized by the electron thermal energy is much greater than the electron-to-ion mass ratio.

11277 Modified Clemmow-Mullaly-Allis diagram for large-amplitude electromagnetic waves in magnetoplasmas. Minami, K. (Tokyo Inst. of Tech. (Japan)). *J. Phys. Soc. Jpn.;* **42**: No. 1, 274-279(Jan 1977).

A possible modification to the well known Clemmow-Mullaly-Allis diagram is analyzed by taking into account the ponderomotive force due to a large-amplitude electromagnetic field in magnetoplasmas. We restrict our attention here to the propagations parallel (the right- and left-hand circularly polarized waves) and/or perpendicular (the ordinary and extraordinary modes) to the static magnetic field. Simple expressions are obtained for the cut-off conditions of the waves except for the extraordinary mode. In the latter case, the cut-off condition is calculated numerically by solving an integral equation. The cut-off lines are shown to move towards the higher densities with increasing wave amplitude.

11278 Sheath resonance in a magnetized sheet plasma. Uehara, K.; Itakura, A.; Hagiwara, S.; Kojima, S. (Tokyo Univ. of Education (Japan). Faculty of Science). *J. Phys. Soc. Jpn.;* **42**: No. 1, 359-360(Jan 1977).

11279 Perturbation method and its application to obliquely propagating nonlinear Alfven wave. Mio, K.; Ogino, T.; Takeda, S. (Nagoya Univ. (Japan). Faculty of Engineering). *J. Phys. Soc. Jpn.;* **41**: No. 6, 2114-2120(Dec 1976).

A procedure to the coordinate stretching and the perturbation expansion for the reductive perturbation method is proposed to analyze the nonlinear wave behaviors in dispersive medium. The method is applied to the nonlinear Alfven wave propagating in an oblique direction to the static magnetic field in cold plasmas. Although the wave is described by a linear equation for some physical quantities, the nonlinearity appears in the relation among the other quantities for considerably large amplitude. These outstanding features are much different from other waves in plasmas.

11280 Radiation fields by the parabolic cylinder in an anisotropic medium. Nagano, I.; Mambo, M. (Kanazawa Univ. (Japan). Faculty of Technology). *Nagoya Daigaku Kankyo Igaku Kenkyusho Nempo;* **10**: No. 2, 71-78(Oct 1976). (In Japanese).

Electromagnetic fields which are radiated by a linear magnetic current in the neighborhood of perfectly conducting parabolic cylinder in an anisotropic medium are solved by using separable coordinates. Unknown coefficients of the scattering term are represented as recurrence formulas because of unperiodicity of the parabolic cylinder coordinates. The convergence of this infinite series is fairly good under the condition that the thickness of the cylinder is thin. Numerical examples of the radiation patterns over the parabolic cylinder are shown in the case when a linear magnetic current is located on the upper part of thin parabolic cylinder.

11281 Parametric coupling of two Langmuir waves in an inhomogeneous plasma. 3. Wave trapping by a density cavity. Ikemura, T. (Kyoto Univ. (Japan). Dept. of Physics). *J. Phys. Soc. Jpn.;* **41**: No. 3, 1002-1013(Sep 1976).

On the basis of the W.K.B. method, it is shown that an inverse triangle density cavity can trap a pair of temporally growing, oppositely propagating electron Langmuir waves; these are parametrically coupled through a combined action of a density gradient inside the cavity and a high-frequency pump electric field which is uniform outside the cavity. The threshold value of the pump intensity for this decay instability is presented as a monotonously increasing function of the scale size of the trapping regions, the mode number, the Debye length, and the minimum threshold above which the decay instability of the convective-type sets in. Consideration of the electron ponderomotive force created by the intense pump field which is non-uniform inside the density cavity leads to a decrease of the density gradient, resulting in an appearance of the upper threshold above which the trapped waves are damped.

11282 Wave phenomena in an ion beam-plasma system. I. Generation of ion beam. Nakajima, K.; Idehara, T.; Ishida, Y. (Fukui Univ. (Japan)). *Fukui Daigaku Kogakubu Kenkyu Hokoku;* **24**: No. 2, 307-311(Sep 1976). (In Japanese).

An ion beam source is constructed, in which the ions are extracted from plasma produced in the TP-D device and accelerated by a grid electrode. As the energy and density of it can be varied independently, the source is suitable for the investigation of wave phenomena in an ion beam-plasma system.

11283 Effects of reflected ions by the envelope of a modulated ion wave. Tajiri, M. (Osaka Prefectural Univ., Sakai (Japan). Coll. of Engineering). *J. Phys. Soc. Jpn.;* **41**: No. 3, 1014-1020(Sep 1976).

Effects of ions reflected by the envelope of a modulated ion wave are investigated by applying the reductive perturbation method to the system of characteristic equations of the Vlasov equation. If we assume that the magnitude of the wave potential is of the order of epsilon, the ions which velocity ranges are of the order of epsilon are reflected by the envelope of the modulated wave. The effects of reflected ions appear as a precursor and it modifies the nonlinear Schroedinger equation, which governs the wave propagation due to the nonresonant ions.

11284 Dynamics of Langmuir wave soliton. Watanabe, M.; Nishikawa, K. (Hiroshima Univ. (Japan). Faculty of Science). *J. Phys. Soc. Jpn.;* **41**: No. 3, 1029-1035(Sep 1976).

Various descriptions for the one-dimensional Langmuir wave soliton are classified according to the relations among various smallness parameters. Four different regimes are found to emerge depending on the relative importance of various forces acting on the electrons and are graphically represented in the parameter space. When the field energy becomes as large as the electron kinetic energy, second harmonic generation and local charge separation (in slow time scale) are found to occur, but their effect on the description of the Langmuir wave soliton is found insignificant. Dynamic behavior of the Langmuir wave soliton is discussed in terms of the trajectory in the parameter space and is compared with recent experimental and numerical analyses.

11285 Propagation of a coherent ion acoustic wave through ion wave turbulence. Yamamoto, T.; Nishio, Y.; Tsukishima, T. (Nagoya Univ. (Japan). Faculty of Engineering). *J. Phys. Soc. Jpn.;* **41**: No. 3, 1021-1028(Sep 1976).

A coherent test wave is allowed to propagate through a stationary and spatially evolving ion wave turbulence which is realized in an unmagnetized argon positive column. It is shown that the observed nonlinear saturation and subsequent damping of the test wave can be well described by an analytic expression based on the theory of perturbed ion orbits, i.e., by an effective increase of ion temperature, provided the initial amplitude of the test wave is less than a threshold value n*sub(k)(0). When the initial amplitude exceeds n*sub(k)(0), generation of subharmonic wave is observed. It is also found that contraction of the wavelength occurs when the test wave with an initial value less than n*sub(k)(0) propagates from a quiescent region to the turbulent region. These phenomena are considered as due to higher-order nonlinear effects.

11286 Nonlinear behavior of Drift wave oscillations in a single-ended Q-device. Watanabe, M. (California Univ., Berkeley (USA). Electronics Research Lab.); Hartman, C.W. *J. Phys. Soc. Jpn.;* **40**: No. 3, 826-829(Mar 1976).

Harmonic Drift wave oscillations accompanied by sidebands have been observed in a single-ended Q-device with collisionless Lithium plasma. The power spectrum of the harmonics is found to fall off with frequency as fsup(-4.8+-0.6) in agreement with the theoretical prediction of plasma turbulence by F.F. Chen. The generation of sidebands due to trapped particles by the wave is inconsistent with the results. It is probably due to the modulation of the drift wave by the low frequency oscillation which is observed simultaneously. A transition from a discrete spectrum to turbulence occurs as the magnetic fields is increased and the formation of turbulence appears to be related to sideband interactions.

FUSION POWER PLANTS

11287 (EPRI-ER—429-SR(Pt.B)) **Four workshops in alternate concepts in controlled fusion. Part B. Extended summaries.** Dawson, J.M. (Electric Power Research Inst., Palo Alto, Calif. (USA)). May 1977. 156p. Dep. NTIS, PC A08/MF A01.

A review has been completed of fourteen alternate fusion reactor concepts that could lead to more practical power plants.

These concepts are in addition to the Tokamak and mirror concepts which are presently receiving the bulk of the U.S. R and D effort. The concept characterizations were assembled by means of workshops and are presented in two sets of summaries. Part A is a concise executive summary written in nontechnical language and suitable for reading by executives who do not require a discussion of scientific details. A longer, more technical summary is presented in Part B. The objective is a presentation of the facts in a neutral tone without overselling or overcriticizing any concept. The concepts reviewed were limited to those employing magnetic confinement techniques for pure fusion power production.

11288 (EPRI-ER—536-SR, pp 23-37) **Utility view of fusion.** Ashworth, C.P. (Pacific Gas and Electric Co., San Francisco). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

The paper first takes a non-concept-specific look at 50 to 50 D-T versus advanced fuel blanket/shield dimensions and concludes that given an effective confinement (beta approximately equal to 1) practical advanced fuel reactors could be enough smaller and less difficult to engineer than D-T to make considerable difference in their timing and use. The author urges more emphasis on tailoring confinement to fit the desired energy plant. An example is given.

11289 (EPRI-ER—536-SR, pp 97-101) **Electric utility view of fusion.** Drew, H.R. Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

The history of the development of electric power plant technology has, until recently, been one of steadily increasing efficiency and declining plant cost per kilowatt of generating capacity. Fusion reactions which produce energetic charged particles offer a dramatic opportunity to continue these trends. In spite of the difficulties, the potential is so attractive that a substantial research effort is warranted.

11290 (EPRI-ER—536-SR, pp 103-121) **Multipole fusion reactors using advanced fuels.** Arnush, D. (TRW Systems Group, Redondo Beach, CA); Conn, R.; Dawson, J.M.; Fried, B.; Kerst, D.; Samec, T.; Vanek, V.; Wong, A.Y. Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

A progress report on a study of the use of advanced fuels in a multipole plasma confinement reactor is presented. As an example, an octopole employing P + ^{11}B is investigated with regard to power flow balance. The results are encouraging, assuming that recent octopole diffusion scaling measurements may be extrapolated to the fusion regime. A conceptual reactor design is used to identify outstanding engineering and physics uncertainties and the conceptual design of an experimental levitated octopole to resolve most of the key issues is presented.

11291 (EPRI-ER—536-SR, pp 133-151) **Migmacell: a low-gain driven fusion power amplifier as an interim energy source.** Maglich, B.C. (Fusion Energy Corp., Princeton, NJ). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

A fusion program less ambitious in its objectives and technology than the official programs, but such that can be reduced to practice before the "ignited" fusion power reactors with "infinite gain" become a reality, is described. "Migmacell" is designed as a "driven" power amplifier with a gain of 1.5 to 3, energized by fusion. By recirculating a significant fraction of the output power, migmacell would become a self-sustained power source of 100 kW/sub e/ to 5 MW/sub e/. Although small (1 m in dia), it can operate at much higher "temperatures" than plasmas, by using direct nuclear collisions, instead of heating; and utilize the environmentally acceptable "advanced fuels." Larger plants are envisioned as a plurality of standardized migmacells. Three stages of the Program are completed. Equipment for Stage 4 (1 year) has been assembled and tested. Stage 5 is a 5-year plan to build a demonstration power unit. Economic projections indicate a competitive power source. State-of-the art technology is assumed throughout.

11292 (EPRI-ER—536-SR, pp 167-177) **Fusion by grand catastrophe.** Sahlin, H.L. (Univ. of California, Livermore). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

The plasma focus, an accidentally discovered natural phenomenon, provides a pulsed power source of 10^{12} to 10^{13} watts in a variety of forms: electron bursts, ion bursts, and the stagnation and direct field heating of the snowplow. High density fusion work being conducted at Livermore with a plasma focus with maximum bank energy of 500 kJ at 40 kV is described. The primary purpose of the project is to employ the plasma focus as a pulsed power source to explore various fusion microexplosion concepts. The first exotic fuel experiments have been carried out at this facility by operating the focus on D_2 + ^{3}He at 120 kJ and 27 kV.

11293 (EPRI-ER—536-SR, pp 189-195) **Radiation emission and production of synthetic fuels.** Eastlund, B.J. (Fusion Systems Corp., Rockville, MD). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

The radiation emitted by fusion reactors has unique characteristics which can be used to produce synthetic fuels such as hydrogen. Direct radiolytic chemical conversion of neutron or x-ray energy is possible. High temperature (2700°K) blankets, suitable for efficient chemical processing, can be designed using radiative heat transfer. The efficiencies of some of these new fuel production techniques are shown to be comparable to or greater than electrolytic hydrogen production using electricity produced by a thermal cycle. The advantages of dual purpose, electricity and fuel producing reactors are discussed. The areas of research and development needed to better define the process are outlined.

11294 (EPRI-ER—536-SR, pp 317-327) **D-^{3}He field-reversed mirror as a minimum-size satellite.** Miley, G.H.; Driemeyer, D. (Univ. of Illinois, Urbana). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

Calculations indicate that D-^{3}He fueled Field-Reversed Mirror (FRM) reactors may be possible with power levels in the megawatt range using plasma volumes of tens of liters. Units could be stacked for higher powers. A bulk of the output power would be in the form of charged-particles and radiation with neutrons carrying <7% of the power. This, combined with the elimination of tritium breeding requirements, makes the design of a long-life, very low-radioactivity blanket possible. Consequently, the D-^{3}He FRM potentially offers a unique satellite (to a D-D or D-T ^{3}He generator) that could be placed in a variety of locations near small load centers such as manufacturing plants and community centers.

11295 (EPRI-ER—536-SR, pp 377-386) **Some new ideas on wet wood burners.** Dawson, J.M.; Lin, A.T. (Univ. of California, Los Angeles). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

A class of wet wood burners is studied in which the ion temperature is maintained by external heating but the electrons rapidly lose energy due to anomalous processes or by impurity radiation. It is assumed that the ion energy confinement is good while that of the electrons is poor, as has been observed in some fusion experiments. One finds that energy multiplications of 10 or greater can be achieved with electron energy confinement times such that ntau/sub E/ > 2 x 10^{13}.

11296 (EPRI-ER—536-SR, pp 435-486) **SURMACS.** Wong, A.Y.; Schumacher, R.; Breun, R.; Miller, L. (Univ. of California, Los Angeles). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

Although advanced fuels with low neutron yields are very desirable, only recently are specific confinement configurations proposed which might contain such fuels reacting at much higher temperatures than DT. One axisymmetric confinement scheme is described here which has low synchrotron radiation, optimum confinement times with wall stabilization, good accessibility to beam and RF heating, steady state operation and can be constructed from modular units. The present status of physics leading to our design is summarized together with crucial problems to be investigated.

11297 **Hypocycloidal pinch device.** Lee, J.H. US Patent 4,042,848. 16 Aug 1977. Filed date 17 May 1974. 6p.

A hypocycloidal pinch device is described comprising three spaced apart coaxially aligned, annular electrodes; means for insulating the outer electrodes from the middle electrode; means for containing the spaced apart electrodes; means for charging the containing means with a working gas; and means for applying pulsed

electrical energy between (a) the outer electrodes and (b) the middle to thereby produce along the coaxial axis a plasma of the working gas. 6 claims, 4 figures.

11298 Pinch effect revisited. Bostick, W.H. *Int. J. Fusion Energy;* **1**: No. 1, vp(Mar 1977).

The history of pinch effect studies is reviewed. Significant studies at Moscow, Princeton, LLL, LASL, Culham, Paris, and Garching are described. (MOW)

11299 Toroidal nuclear fusion device. Kurita, I.; Hashimoto, H.; Ito, Y.; Takizawa, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-113100/A/. 28 Mar 1975. 3p. (In Japanese).

Object: To positively and easily support a poloidal coil by the use of support means of simple construction. Structure: A poloidal coil support member disposed between toroidal coils wound in a toroidal peripheral direction of a vacuum container in the form divided in plurality and astride of the container is formed with a groove extending through in the toroidal peripheral direction, thereby supporting the poloidal coil in the groove.

PHYSICS AND BLANKET ENGINEERING

11300 (EPRI-ER—536-SR, pp 57-67) **Fusion blankets for catalyzed D-D and D-^{3}He reactors.** Fillo, J.A.; Powell, J.R. (Brookhaven National Lab., Upton, NY). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

Blanket designs are presented for catalyzed D-D (Cat-D) and D-He^3 fusion reactors. Because of relatively low neutron wall loads and the flexibility due to non-tritium breeding, blankets potentially should operate for reactor lifetimes of approximately 30 years. Unscheduled replacement of failed blanket modules should be relatively rapid, due to very low residual activity, by operators working either through access ports in he shield (option 1) or directly in the plasma chamber (option 2). Cat-D blanket designs are presented for high (approximately 30%) and low (approximately 12%) β noncircular Tokamak reactors. The blankets are thick graphite screens, operating at high temperature to anneal radiation damage; the deposited neutron and gamma energy is thermally radiated along internal cavities and conducted to a bank of internal SiC coolant tubes (approximately 4 cm. ID) containing high pressure helium. In the D-He^3 Tokamak reactor design, the blanket consists of multiple layers (e.g., three) of thin (approximately 10 cm) high strength aluminum (e.g., SAP), modular plates, cooled by organic terphenyl coolant.

11301 (EUR-CEA-FC—875) **Recent results on plasma-wall interaction in the T.F.R. Tokamak.** (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Jan 1977. 23p. (CONF-761049—10). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International symposium on plasma wall interaction; Julich, F.R. Germany (18 Oct 1976).

Phenomena related to plasma-wall interaction in the T.F.R. Tokamak are briefly surveyed; the technological modifications made after February 1976 are described, and the latest results are presented. They deal with the dynamics of impurities as revealed by various injection experiments, with the effect of reducing the limiter radius, and with the consequences of using boron carbide and graphite limiters. Finally, some physical conclusions are drawn from the results obtained.

11302 (TRITA-PFU—77-03) **Main features and potentialities of gas-blanket systems.** Lehnert, B. (Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik med Fusionsforskning). Feb 1977. 59p. Dep. NTIS (US Sales Only), PC A04/MF A01.

A review is given of the features and potentialities of gas-blanket systems, with respect to plasma equilibrium, stability, and reactor technology. The treatment is mainly concentrated on quasi-steady magnetized plasmas confined at moderately high beta values. In these systems the plasma becomes separated from the blanket only when the ion density is chosen far inside the impermeable regime. Steady solutions exist within limited parameter ranges. The pressure and density profiles are affected by ionization of neutral gas, by the presence of various atom species and impurities, as well as by Nernst, toroidal, and anomalous effects. Further, the partially ionized boundary layer becomes diamagnetic, the blanket pressure does not balance the plasma pressure, the heat balance determines the boundary layer thickness, and the strongly inhomogeneous distributions of the plasma and the neutral gas parameters in space modify the stability properties, especially on account of an existing boundary layer. The gas-blanket approach has certain important potentialities as fusion reactor, e.g. in connection with the desired densities and dimensions of full-scale systems, refuelling as well as ash and impurity removal, and stability.

11303 Basic characteristics of an efficient fusion breeder. Gordon, C.W.; Harms, A.A. (McMaster Univ., Hamilton, Ontario (Canada). Dept. of Physics). *Atomkernenergie;* **29**: No. 3, 213-220(1977).

Some reactor physics characteristics of an efficient fusion breeder, consisting of an integrated fusion-fission reactor system with fissile and fusile fuel linkages, are examined. Core parameters of existing fission reactors and proposed fusion reactors are used to determine the system fissile fuel breeding gain, the fissile fuel doubling time, the nuclear fuel production capacity and the ratio of fusion-to-fission thermal power. It is concluded that such a symbiotic reactor configuration possesses considerable merit from the standpoint of long-term supply of fissile fuel and provides new options for the development of the next generation of nuclear energy systems.

11304 Basic studies on the blanket design of controlled thermonuclear reactors. Sekiguchi, A. (Tokyo Univ. (Japan). Faculty of Engineering). *Tonind.-Ztg. Keram. Rundsch.;* **35**: 199-208(Sep 1976). (In Japanese).

The second year program of the basic studies on the CTR-blancket design was completed in success to obtain interesting findings and experiences in each relevant technical area. In order to approach systematically to the problem of system feasibility of CTRs, a conceptual design study on the Tokamak-type CTR-blancket has been continued along with the associated elemental problems. Included in this report are the research activities in the following areas: fusion reactor materials, ion accelerator, neutronics, superconducting magnet, neutron beam source, tritium fuel, reactor system design, mechanics, and heat removal.

11305 Device for enclosing plasma (TOKAMAK device). Fukushima, H.; Kitamura, K. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-113097/A/. 29 Mar 1975. 4p. (In Japanese).

Object: To speedily cool a movable limiter capable of controlling a plasma diameter thereby reducing out-of-operation time and stabilizing the device. Structure: Arranged within an intense magnetic field is a vacuum container, in which plasma is enclosed under magnetic pressure, and a movable limiter capable of controlling plasma-diameter is disposed in the vacuum container, the movable limiter being placed in intimate contact with the surface of inner wall of the vacuum container, the outer wall surface of the vacuum container, with which the limiter is placed in intimate contact being selectively cooled.

11306 Nuclear fusion reactor. Hino, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-101698/A/. 5 Mar 1975. 2p. (In Japanese).

Object: To prevent reduction of plasma temperature by discharging, from the vacuum discharge holes on opposite sides of a limiter in TOKAMAK nuclear fusion reactor, impurity atoms and impurity ions released from said limiter. Structure: Vacuum discharge holes are provided on opposite sides of the limiter, and impurity atoms and impurity ions released from the limiter are discharged to the outside of the vacuum envelope from the vacuum exhaust holes by a vacuum exhaust system. Thus, there is no possibility that impurity atoms and impurity ions released from the limiter will invade the plasma, and hence there is no possibility of plasma temperature reduction.

11307 Nuclear fusion reactor. Inoue, K.; Hino, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-101699/A/. 5 Mar 1975. 3p. (In Japanese).

Object: To prevent the emission of impurities from a limiter by the irradiation of a beam of high pressure heavy hydrogen or tritium between the plasma and limiter in a Tokamak type nuclear reactor. Structure: A vacuum wall having beam inlet and outlet bores. A beam of high pressure heavy hydrogen or tritium is injected through the inlet bore over the boundary area between the limiter and the plasma and recovered from the outlet bore. This serves to prevent the emission of impurities from the limiter and therefore the cooling of the plasma.

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 11347

11308 (EPRI-ER—536-SR, pp 69-81) **Magnet system for catalyzed D-D and D-^{3}He reactors.** Usher, J.L.; Powell, J.R.; Hsieh, S.Y. (Brookhaven National Lab., Upton, NY). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

A new concept for toroidal field magnets, called the DEALS (Demountable Externally anchored Low Stress) magnet system, has been conceived and developed for advanced fuel reactors. This concept should result in substantial cost reductions for toroidal magnets. In addition, the conductor stress is relatively low and

compressive in nature, which is very important if brittle Nb_3Sn conductors are to be successfully used, since advanced fuel Tokamak reactors require Nb_3Sn conductor if reasonable power densities are to be achieved. A final very important benefit of the DEALS magnet system is its demountability. Failed magnet segments can probably be replaced fairly rapidly (i.e., in approximately a month) without requiring movement and/or disassembly of the blanket/shield regions and poloidal coils. Due to the high degree of non-circularity present in the plasmas of the low-β Tokamak reactor designs which are detailed in this report, a system of poloidal field coils is necessitated to provide both shape and positional stability. In addition, the uncertainty regarding the accessibility of the high-β regimes discussed may also necessitate extensive poloidal field system. Volt second requirements are such that they must be alleviated also by this poloidal field system.

11309 (KFTI—75-21) **Diffusion of stellarator magnetic fields into hollow circular cylinders.** Aleksin, V.F.; Romanov, S.S. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1975. 17p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

The diffusion of time dependent, helical, undulated magnetic fields and of the field of azimuthal currents is studied with the Laplace method. The penetration times for the given fields are found. The damping coefficients of the fields are calculated. The phases of the penetrated and external fields are determined. The magnetic permeability, which is different from 1, is calculated for the conductors.

11310 (UCRL—79744) **Coil winder for the magnet of the mirror fusion test facility.** Ling, R.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 Aug 1977. Contract W-7405-ENG-26. 6p. (CONF-771029—1). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, Tennessee, USA (25 Oct 1977).

A coil winder was designed for the purpose of fabricating the superconducting magnets of the Mirror Fusion Test Facility. The superconducting magnets are a displaced ying-yang pair, each having major and minor radii of 2.5 and 0.75 m, respectively, and cross section of 0.42 m by about 1.03 m. The superconductor cross section is a square, 13 mm on a side, and consists of a core of niobium-titanium embedded copper and a solid copper stabilizer. Conceptual studies made at Lawrence Livermore Laboratory of the coil winder resulted in concept drawings and a procurement specification. Final design was made by the contractor, and the coil winder is now in fabrication. This paper describes the performance requirements of the winder, and the evolution of its design from conceptual stage to completion.

11311 **Coil for nuclear fusion device.** Kadotani, K.; Umeda, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-114596/A/. 2 Apr 1975. 4p. (In Japanese).

Object: To flatten the surface of a coil insulating layer to prevent concentration of stress applied thereto, thereby enhancing dielectric strength and to decrease weight of the nuclear fusion device. Structure: A layer of resin strengthened with carbon-glass fabrics is coated on the outer periphery of an annularly wound coil with an insulating layer attached to the outer surface thereof in a manner such that the carbon fibrous yarns are oriented in a peripheral direction and the glass fibrous yarns oriented at right angles to the peripheral direction.

11312 **Coil composed of composite conductors.** Ito, Y.; Kurita, I.; Hashimoto, H.; Kazawa, Y. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-113099/A/. 28 Mar 1975. 3p. (In Japanese).

Object: To increase a stress resisting property of poloidal coils or the like used in a nuclear fusion device. Structure: A composite conductor, in which electrolytic copper and non-magnetic high-stress-resisting alloy are integrally formed by way of brazing, welding, screw-fastening and the like, is wound to form a coil, and an electric current of the coil is simultaneously flown in parallel along both the electrolytic copper and the high-stress-resisting alloy, the high-stress-resisting alloy being always positioned on the outer peripheral side of the coil so that as the stress approaches toward a yield point of the electrolytic copper, the electromagnetic force borne by the high-stress-resisting alloy increases in rate to prevent breakage of the coil.

11313 **Toroidal nuclear fusion device.** Takizawa, T.; Kurita, I.; Ito, Y.; Hashimoto, H. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-113098/A/. 28 Mar 1975. 4p. (In Japanese).

Object: To support a poloidal coil within a narrow space with sufficient strength. Structure: A fixed member formed with a groove extending through in a toroidal peripheral direction is disposed between toroidal coils wound in the toroidal peripheral direction of the vacuum container in the form divided in plurality in order to hold plasma enclosed in the vacuum container, thereby supporting in the groove a poloidal coil wound along the toroidal peripheral direction of the vacuum container, the outer periphery of the poloidal coil at least in a portion in contact with the groove being covered by a reinforcing member.

POWER SUPPLIES AND CIRCUITRY

11314 **Power source system for nuclear fusion.** Nakagawa, S. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-121696/A/. 17 Apr 1975. 5p. (In Japanese).

Object: When using an external system power source and an exclusive power source in a power source circuit for supplying power to the coils of a nuclear fusion apparatus, to minimize the capacity of the exclusive power source and provide an economical power source circuit construction. Structure: In the initial stage of the power supply, rectifying means provided in individual blocks are connected in parallel on the AC side, and power is supplied to the coils of the nuclear fusion apparatus from an external system power source with the exclusive power source held in the disconnected state. Further, at an instant when the limit of permissible input is reached, the afore-mentioned parallel circuit consisting of rectifying means is disconnected, while at the same time the exclusive power source is connected to the input side of the rectifying means provided in a block corresponding to the exclusive power source side, thereby supplying power to the coils of the nuclear fusion apparatus from both the external system power source and exclusive power source.

COOLING SYSTEMS

REFER ALSO TO CITATION(S) 11346, 11348

FUEL SYSTEMS

REFER ALSO TO CITATION(S) 11344, 11349

11315 (EPRI-ER—429-SR(Pt.A)) **Four workshops in alternate concepts in controlled fusion. Part A. Executive summaries.** Dawson, J.M. (Electric Power Research Inst., Palo Alto, Calif. (USA)). May 1977. 57p. Dep. NTIS, PC A04/MF A01.

A review has been completed of fourteen alternate fusion reactor concepts that could lead to more practical power plants. These concepts are in addition to the Tokamak and mirror concepts which are presently receiving the bulk of the U.S. R and D effort. The concept characterizations were assembled by means of workshops and are presented in two sets of summaries. Part A is a concise executive summary written in nontechnical language and suitable for reading by executives who do not require a discussion of scientific details. A longer, more technical summary is presented in Part B. The objective is a presentation of the facts in a neutral tone without overselling or overcriticizing any concept. The concepts reviewed were limited to those employing magnetic confinement techniques for pure fusion power production.

11316 (EPRI-ER—429-SR(Pt.C)) **Four workshops in alternate concepts in controlled fusion. Part C. CTR using the p-^{11}B reaction.** Dawson, J.M. (Electric Power Research Inst., Palo Alto, Calif. (USA)). May 1977. 44p. Dep. NTIS, PC A03/MF A01.

Clean and efficient energy production by fusion is possible in principle by using any one of a variety of so called advanced fusion fuels. Among these choices, the nuclear reaction of protium (p) and boron-11 (B^{11}) offers the benefits of a large reaction cross section, no neutron production, and no tritium production or consumption. Compared with deuterium-tritium (D—T) fusion systems, these characteristics offer significant engineering and operational potential. Use of the p-B^{11} fuel cycle requires high temperature and very effective plasma confinement. Based on new confinement results in magnetic multipole configurations, our recalculation of the p-B^{11} energy balance for selected operating conditions shows the possibility for significant energy production. Radiation losses are reduced to an acceptable level by two means: one, operation at an ion temperature of 300 keV and an electron temperature of 150 keV, and two, reducing the magnetic field in the bulk of the plasma to a small value by use of the multipole configuration. The multipole configuration is available to the neutron-free p-B^{11} cycle but not the D-T cycle because it employs internal cryogenic conductors. Energy conversion is proposed by means of radiative transfer to the walls of the reactor. Critical issues include uncertainties in the p-B^{11} cross section, the achievable level of field free region and the confinement scaling to reaction temperatures, effects of helium ash, and the level of neutron production by parasitic reactions.

11317 (EPRI-ER—536-SR) **Proceedings of the review meeting on advanced-fuel fusion.** Choi, C.K. (ed.). (Illinois Univ., Urbana (USA)). Sep 1977. 508p. (CONF-770644—). Dep. NTIS, PC A021/MF A01.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

Separate abstracts were prepared for each of the 35 included papers. (MOW)

11318 (EPRI-ER—536-SR, pp 15-21) **Comments on advanced-fuels and workshop objectives.** Miley, G.H. (Univ. of Illinois, Urbana). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

To provide additional background for the workshop groups, highlights from a 1973 report to the Edison Electric Institute on the development of advanced-fuel fusion reactors are reviewed.

11319 (EPRI-ER—536-SR, pp 39-56) **Advanced-fuel fusion systems. The D-^{3}He satellite approach (the ILB reactors).** Miley, G.H.; Southworth, F.S.; Choi, C.; Gerdin, G. (Univ. of Illinois, Urbana). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

A system of ^{3}He-generator—D-^{3}He satellite fusion power plants is proposed. Either high-breeding-ratio D-T reactors or D-D reactors would serve as generators while several different concepts (D-^{3}He fueled tokamaks, bumpy tori, and field-reversed mirrors) are considered for satellites in order to offer satellite power levels ranging from approximately 3GW(e) to 10MW(e). The satellites, due to their relative cleanliness and flexibility in size, could be located near the user while generators would be in more remote "parks." This requires shipment of ^{3}He, but this appears to be safe and straightforward. The freedom to design the satellite blanket without concern for tritium breeding makes simplifications possible which are essential for small plants where the "economy of size" no longer applies.

11320 (EPRI-ER—536-SR, pp 197-209) **General requirements and approaches to advanced fuel fusion.** McNally, J.R. Jr. (Oak Ridge National Lab., TN). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

A new fusion ignition parameter (Tn/sub e/tau/sub E/) is proposed which is proportional to β^2B^4 (or n^2T^2) and inversely proportional to the fusion power density of a reacting plasma. Ignition curves are given for many potential nuclear fusion fuels, and comparison is made with existing experiments. Prospects are presented for some advanced fusion fuels.

11321 (EPRI-ER—536-SR, pp 211-221) **Cross section requirements.** Turner, J.M. (Energy Research and Development Administration, Washington, DC). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

Nuclear cross section requirements for potential advanced fuels are discussed. The emphasis is on three systems: P-^{11}B, P-^{6}Li, and D-^{3}He. A suggested order of priorities for these cases is also included. Other fuel options, less promising than the three cited above, are mentioned briefly.

11322 (EPRI-ER—536-SR, pp 223-232) **Cross section measurements and needs.** Norbeck, E. (Univ. of Iowa, Iowa City). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

There are only a limited number of nuclear reactions between charged particles that have a significant cross section at energies available in a fusion reactor. Cross sections should be determined for all of these reactions. A nuclide may be introduced into the reaction region as a fuel component, as a reaction product, or as an impurity. The ^{6}Li-^{6}Li and ^{3}He-^{6}Li reactions have not been adequately considered from a fusion point of view. These two reactions are discussed in detail both for their intrinsic importance and as examples of the kind of reactions that occur between the more complex nuclei.

11323 (EPRI-ER—536-SR, pp 233-239) **Recent ^{11}B(p,3α) cross section measurements.** Tombrello, T.A. (California Inst. of Tech., Pasadena). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

The renewed interest in using the ^{11}B(p,3α) reaction in advanced fuel fusion has made it important to have accurate nuclear reaction cross-section data for feasibility evaluations. The purpose of this note is to present the most recent (and reliable) data for the ^{11}B(p,3α) cross section and for its (sigma v).

11324 (EPRI-ER—536-SR, pp 241-250) **Advanced fuel bumpy tori.** Gerdin, G.A.; Southworth, F.H.; Stark, R. (Univ. of Illinois, Urbana). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

Using neoclassical bumpy torus scaling and theoretical predictions of high β bulk plasma stability, the feasibility of the relativistic electron ring bumpy torus has been studied as an advanced fuel reactor. Preliminary results indicate that modest size (600 MW/sub e/ to 1200 MW/sub e/) D-^{3}He reactors are achievable under these assumptions with high Q/sub e/ ($>$20) and low neutron wall loading ($\leq$ 0.05 MW/m^2). The latter result coupled with the steady state nature of the device should result in high availability.

11325 (EPRI-ER—536-SR, pp 251-260) **Start-up of advanced fuel tokamaks.** Gerdin, G.A. (Univ. of Illinois, Urbana). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

The start up of advanced fuel tokamaks is analyzed to determine if there are any specific challenges related to the start-up of these tokamaks (Cat. D, D^{3}He) that are not found in a DT tokamak. High neutral particle power and neutral beam penetration have been envisioned as such challenges. The results indicate that using an advanced fuel enriched with tritium the plasma can first achieve D-T ignition and runaway to high temperature. Thus using this "match head" technique and low initial density and size ignition of the advanced fuel tokamak can be achieved with about the same external neutral beam energy and power requirements as a D-T device. However unless care is taken in the refueling sequence very high transient neutron wall loadings may result.

11326 (EPRI-ER—536-SR, pp 261-273) **Fusion reactors based on ^{6}Li(p,α)^{3}He.** Hirshfield, J.L. (Yale Univ., New Haven). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

Preliminary estimates are given of the parameters required for energy breakeven and for 100 MW/sub e/ power production in a thermonuclear reactor based on the catalyzed p-^{6}Li fusion reaction. Energy yields are also calculated for this reaction in a two-component reactor, using a crude proton slowing-down formula.

11327 (EPRI-ER—536-SR, pp 275-284) **Optimization of plasma profiles for ignited low-beta toroidal plasmas utilizing advanced fuels.** Jassby, D.L.; Towner, H.H. (Princeton Univ., NJ). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

The radial density and temperature profiles of ignited plasmas utilizing non-DT fuels can be optimized to maximize fusion power density and minimize required anti n tau/sub E/ under the constraint of a maximum average plasma pressure. Strong axial temperature peaking or strong density peaking is advantageous, according to whether the fusion reactivity increases faster or more slowly than quadratically with temperature, respectively. For tokamak plasmas with maximum beta limited to 10% or less by MHD instability, optimal profile tailoring allows ignition of catalyzed D-D or D-^{3}He fuels in devices of reasonable size (R_0 approximately less than 8 m), and with first-wall power loadings exceeding 1 MW/m^2.

11328 (EPRI-ER—536-SR, pp 285-294) **Use of a hot sheath Tormac for advance fuels.** Levine, M.A. (Univ. of California, Berkeley). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

The use of hot electrons in a Tormac sheath is predicted to improve stability and increase ntau by an order of magnitude. An effective ntau for energy containment is derived and system parameters for several advance fuels are shown. In none of the advance fuels cases considered is a reactor with fields greater than 10 Wb or major plasma radius of more than 3 m required for ignition. Minimum systems have power output of under 100 MW thermal. System parameters for a hot sheath Tormac have a wide latitude. Sizes, magnetic fields, operating temperatures can be chosen to optimize engineering and economic considerations.

11329 (EPRI-ER—536-SR, pp 295-306) **Prospects for DD tantem mirror.** Logan, G. (Univ. of California, Livermore). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

The possibility of burning advanced fusion fuels in a tandem mirror is considered for a catalyzed DD cycle, in which the T and ^{3}He reaction products from DD burn in both the solenoid and plugs are reinjected for complete burnup: $3D \rightarrow p + {}^4He + n + 21.6$ MeV. Classical radial transport of the ^{4}He ash determines the steady state alpha fraction in the solenoid. Synchrotron radiation losses are minimized at high beta, such that charged particle fusion power recovered in a direct converter exceeds radiation losses by a factor greater than two. An overall system $Q = 4.5$ is found for one reactor example but the power output is large (3 GW(e) net) due to the low power density in the solenoid. Optimizing recirculating power cost (Q) against plug/solenoid density ratio (power density) should result in much smaller reactor size and cost.

11330 (EPRI-ER—536-SR, pp 307-315) **Autobibliography on ion-layer production, properties, needs, and applications.** McNally, J.R. Jr. (Oak Ridge National Lab., TN). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

An autobibliography on advanced fusion fuels and the Ion-layer plasma electromagnetic fusion configuration is presented. This was prepared at the request of G.H. Miley for distribution at the EPRI Review Meeting and was presented as part of the poster session.

11331 (EPRI-ER—536-SR, pp 329-336) **Comments about p-^{11}B ignition.** Miley, G.H. (Univ. of Illinois, Urbana). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

Ignited (or nearly-ignited) operation appears to be essential for a favorable energy balance when using p-^{11}B. Calculations show that even with optimistic cross sections and the elimination of cyclotron radiation, ignition requires an electron-ion temperature ratio $< 1/5$ and T/sub i/ > 120 keV. Such calculations are sensitive to both detailed numerical methods and the plasma modeling; consequently, it is suggested that interested workers set up a benchmark problem so that various approaches can be intercompared.

11332 (EPRI-ER—536-SR, pp 355-363) **Catalyzed deuterium fueled tokamak reactors.** Southworth, F.H. (Univ. of Illinois, Urbana). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

Catalyzed deuterium fuel presents several advantages relative to D-T. These are, freedom from tritium breeding, high charged particle power fraction and lowered neutron energy deposition in the blanket. Higher temperature operation, lower power densities and increased confinement are simultaneously required. However, the present study has developed designs which have capitalized upon the advantages of catalyzed deuterium to overcome the difficulties associated with the fuel while obtaining high efficiency.

11333 (EPRI-ER—536-SR, pp 365-376) **D-^{3}He fueled tokamak reactors.** Southworth, F.H. (Univ. of Illinois, Urbana). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

D-^{3}He offers the highest power density of the advanced fusion fuels at elevated temperatures. As the fuel for a Tokamak reactor, the advantage of reduced neutron production (vs. CAT-D or D-T) can lead to significant simplification in blanket and shield design and possibly, in siting. A small size (~8 m. major radius) Tokamak reactor using D-^{3}He seems an attractive and feasible potentiality. Providing the ^{3}He fuel appears to be the major difficulty, but a D-D breeder/D-^{3}He satellite may fulfill this need.

11334 (EPRI-ER—536-SR, pp 387-402) **Multipoles as reactors.** Dawson, J.M. Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

A review of the multipole concept is given. The use of multipole reactors using p-^{11}B fuels is described. Some advantages of a neutronless environment and the energy balance prospects of such a device are discussed. (MOW)

11335 (EPRI-ER—536-SR, pp 403-433) **CTR using the P-^{11}B reaction.** Dawson, J.M. Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

The possibility of achieving useful energy release from the neutronless p-^{11}B reaction in a magnetically confined plasma device is examined. Some calculational details are given for the following: (1) thermonuclear reaction rate, (2) bremsstrahlung, (3) cooling of the ions by electrons, (4) fraction of the reaction power going directly to the ions, (5) synchrotron losses, and (6) feasibility of using multipolar configurations. (MOW)

11336 (TRITA-EPP—77-02) **Dynamics of a coaxial plasma gun.** Raadu, M.A. (Tekniska Hoegskolan, Stockholm (Sweden). Institutionen foer Plasmafysik). Jan 1977. 30p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The dynamics of an ionizing wave in a coaxial plasma gun with an azimuthal bias magnetic field is analysed in a theoretical model. Only the radial dependence is treated and instead of including a treatment of the energy balance two separate physical assumptions are made. In the first case it is assumed that the total internal electric field is given by the critical ionization velocity condition and in the second that the ionization rate is constant. For consistency wall sheaths are assumed to match the internal plasma potential to that of the walls. On the basis of momentum and particle balance the radial dependence of the electron density, current density, electric field and drift velocity are found. An electron source is required at the cathode and the relative contribution from ionization within the plasma is deduced. The assumption that there are no ion sources at the electrodes leads to a restriction on the possible values of the axial electric field.

11337 (UCID—17573) **Mechanical design criteria for continuously operating neutral beams.** Vosen, S.R.; Bender, D.J.; Fink, J.H.; Lee, J.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Aug 1977. Contract W-7405-ENG-48. 29p. Dep. NTIS, PC A03/MF A01.

A schematic of a neutral beam injector is shown. Neutral gas is injected into the ion source, where a discharge ionizes the gas. The ions are drawn from the source by an extractor grid and then accelerated to full energy by the accel grids. After acceleration the ions pass through the neutralizer cell. Once through the neutralizer cell, the beam consists of neutrals and ions. The ions traveling with the beam are space charge neutralized by background electrons. The grid which precedes the direct converter is negatively charged and acts to separate the electrons from the rest of the beam. As a result of the beam's uncompensated space charge the remaining ions spread out from the beam to be collected at the direct converter. This paper presents a generalized analysis which will be useful in determining effects of energy and particle fluxes on the long-term performance of the grids. (MOW)

11338 **Laser induced photonuclear and fusion-reactions.** LoDato, V.A. (Simulating Science and Engineering, Wappingers Falls, N.Y. (USA)). *Atomkernenergie;* **29**: No. 4, 272-278(1977).

The energy release from the fusion-fission pellets is demonstrated. It is shown that the coupling of the fusion-fission process is extremely efficient provided one can obtain the proper compression heating. The pellet of an outer core of (Li6D-Li6T) with an inner core of U238 is shown to be an efficient and practical fuel and can be ignited by the present generation of lasers to produce thermonuclear burn. The demonstration of the efficiency for photonuclear and photofission pellets is shown. However no suitable gamma ray source exists at present to initiate these processes.

11339 **α-particle generator pellet - a possible commercial power pellet.** LoDato, V.A. (Simulating Science and Engineering, Wappingers Falls, N.Y. (USA)). *Atomkernenergie;* **29**: No. 3, 229-230(1977).

11340 **Three-phase pellets for inertial confinement fusion reactor systems burning waste uranium from fission reactor.** Seifritz, W. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). *Atomkernenergie;* **29**: No. 4, 300-301(1977).

11341 **Production of uniform micropellets of hydrogen and hydrogen pellet injection on ORMAK.** Foster, C.A. Urbana, IL; Univ. of Illinois (1977). 133p. University Microfilms Order No. 77-14,947. Thesis (Ph. D.).

Injecting pellets of solid deuterium-tritium has been previously proposed as a method for refueling fusion reactors based on the magnetic confinement of a plasma. An experimental study was undertaken to determine the interaction of a hydrogen pellet with a high temperature plasma. An apparatus was developed which produced 70 micrometer diameter droplets of hydrogen by the acoustic disintegration of a liquid jet. The liquid drops were frozen and injected into vacuum at a speed of 95 M/sec. The pellet injection apparatus was mounted on ORMAK tokamak magnetic confinement device located at Oak Ridge National Laboratory. Hydrogen pellets

were injected into the ORMAK plasma. The pellet-plasma interaction was monitored by the enhanced neutral line emission of the ablating molecular hydrogen excited by the plasma electrons. The data indicated a pellet lifetime of 350 to 450 μ sec which implied an injection distance of 3.3 to 4.1 cm into the edge of the ORMAK plasma along the injection path which was at an angle of 45° from a radial line. FASTAX movies were taken of the pellets entering the plasma. A luminous cloud much larger than the pellets was observed sequentially on four frames. A model was developed in which the ablation rate of the pellets was regulated by the dynamic formation of a dense shielding cloud surrounding the pellet. The cloud thickness is such that the electrons from the plasma lose most of their energy before striking the pellet surface. The model was in good agreement with both the experimental pellet lifetime and the observed ablation cloud. This model predicts that a 400 micrometer diameter pellet injected at 2.5 x 10^3 M/sec would penetrate to the center of the ORMAK plasma.

11342 Model of an ablating solid hydrogen pellet in a plasma. Parks, P.B. Urbana, IL; Univ. of Illinois (1977). 162p. University Microfilms Order No. 77-15,000.

Thesis (Ph. D.).

An analytical model for the ablation dynamics of a solid hydrogen pellet in a plasma was formulated. The need for a new model became evident as a result of recent pellet injection experiments which showed that pellets vaporized much faster than predicted by existing theories. In this model molecules are vaporized off the surface of the pellet as a result of the elevated pellet surface temperature. The ablated molecules flow away from the surface of the pellet and simultaneously attenuate the incoming plasma electron energy flux due to elastic and inelastic collisions. The resulting thermal energy source provided to the flow controls the velocity of the flow just over the pellets' surface and provides a subtle connection between the pellet surface conditions and this gas-dynamic expansion of the "ablation cloud." A set of scaling laws is derived from the analysis in the asymptotic limit of high density plasmas (n/sub eo/ approximately greater than 10^{13} cm^{-3}) or large pellets (r/sub p, scales as approximately greater than .01 cm). For example, it is discovered that the pellet surface regression speed, r/sub p/, scales as r/sub p/ α n/sub eo//sup 1/3/-r/sub p//sup -2/3/T/sub eo//sup 1/2/Λ//sup -2/3/ where Λ is an "effective energy flux cross section" which is related to the plasma electron temperature as Λ approximately T/sub eo//sup -1.59/.

11343 Analysis of hybrid computer simulation of a power level control system for a tokamak fusion reactor plasma. Lipner, M.H. Pittsburgh; Carnegie-Mellon Univ. (1977). 169p. University Microfilms Order No. 77-19,193.

Thesis (Ph. D.).

A hybrid computer simulation has been developed in which alternative assumed physical characteristics of a tokamak-type plasma could be combined in flexible, self-consistent models. The variations in assumed plasma physical characteristics included the mode of particle confinement, the dependence of plasma dimension on plasma temperature, the energy of ion injection and the relation between particle and energy confinement.

RADIATION HAZARDS

REFER ALSO TO CITATION(S) 11340

POWER CONVERSION SYSTEMS

11344 (EPRI-ER—536-SR, pp 83-96) **Direct energy conversion and neutral beam injection for catalyzed D and D-^{3}He tokamak reactors.** Blum, A.S.; Moir, R.W. (Univ. of California, Livermore). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

The calculated performance of single stage and Venetian blind direct energy converters for Catalyzed D and D—^{3}He Tokamak reactors is discussed. Preliminary results on He pumping are outlined. The efficiency of D and T neutral beam injection is reviewed.

11345 (EPRI-ER—536-SR, pp 179-188) **High thermal efficiency advanced fuel fusion reactors.** Taussig, R.T. (Mathematical Sciences Northwest, Inc., Bellevue, WA); Hertzberg, A. Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

A new radiation energy conversion scheme is presented which has the potential for operating at high conversion efficiencies on the order of 60 to 70 percent. Two new device concepts, an x-ray radiation boiler and an energy exchanger, permit radiation energy extraction through a low-Z reactor first wall to a high-Z working fluid which is heated volumetrically to temperatures of 2000 to 3000°K. The energy exchanger transfers the high temperature working fluid energy to a lower temperature working fluid which drives a conventional turbine. This scheme is applied to radiation energy conversion from a p^{11}B fusion reaction, using a single reheat topping and bottoming cycle combination. The high thermal efficiency of this cycle permits an otherwise marginal advanced fusion reactor to become a more attractive net power producer.

11346 (EPRI-ER—536-SR, pp 337-342) **Reactor technology: power conversion systems and reactor operation and maintenance.** Powell, J.R. (Brookhaven National Lab., Upton, NY). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

The use of advanced fuels permits the use of coolants (organic, high pressure helium) that result in power conversion systems with good thermal efficiency and relatively low cost. Water coolant would significantly reduce thermal efficiency, while lithium and salt coolants, which have been proposed for DT reactors, will have comparable power conversion efficiencies, but will probably be significantly more expensive. Helium cooled blankets with direct gas turbine power conversion cycles can also be used with DT reactors, but activation problems will be more severe, and the portion of blanket power in the metallic structure will probably not be available for the direct cycle, because of temperature limitations. A very important potential advantage of advanced fuel reactors over DT fusion reactors is the possibility of easier blanket maintenance and reduced down time for replacement. If unexpected leaks occur, in most cases the leaking circuit can be shut off and a redundant cooling circuit will take over the thermal load. With the D-^{3}He reactor, it appears practical to do this while the reactor is operating, as long as the leak is small enough not to shut down the reactor. Redundancy for Cat-D reactors has not been explored in detail, but appears feasible in principle. The idea of mobile units operating in the reactor chamber for service and maintenance of radioactive elements is explored.

11347 (EPRI-ER—536-SR, pp 343-353) **Bundle divertor designs for attaching direct convertors to the ILB advanced fuel tokamaks.** Southworth, F.H.; Swift, G.M. (Univ. of Illinois, Urbana). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

Extensive parametric surveys of bundle divertor scaling have been conducted. These have resulted in attractive divertor designs for attaching direct converters to the "ILB" CAT-D and D-^{3}He fueled Tokamak reactors. Three conductor types were examined: warm copper, cryogenic aluminum, and Nb_3Sn superconducting. In general, the cryogenic aluminum bundled divertor designs were the most attractive, resulting in low coil power consumption, smaller size, and minimal disturbance of the bulk plasma. It appears that, for advanced fuels, the bundle divertor is a sensible alternative to other divertor types.

11348 (EPRI-ER—544) **High thermal efficiency, radiation-based advanced fusion reactors. Final report.** Taussig, R.T. (Mathematical Sciences Northwest, Inc., Bellevue, Wash. (USA)). Apr 1977. 131p. Dep. NTIS, PC A07/MF A01.

A new energy conversion scheme is explored in this study which has the potential of achieving thermal cycle efficiencies high enough (e.g., 60 to 70 percent) to make advanced fuel fusion reactors attractive net power producers. In this scheme, a radiation boiler admits a large fraction of the x-ray energy from the fusion plasma through a low-Z first wall into a high-Z working fluid where the energy is absorbed at temperatures of 2000°K to 3000°K. The hot working fluid expands in an energy exchanger against a cooler, light gas, transferring most of the work of expansion from one gas to the other. By operating the radiation/boiler/energy exchanger as a combined cycle, full advantage of the high temperatures can be taken to achieve high thermal efficiency. The existence of a mature combined cycle technology from the development of space power plants gives the advanced fuel fusion reactor application a firm engineering base from which it can grow rapidly, if need be. What is more important, the energy exchanger essentially removes the peak temperature limitations previously set by heat engine inlet conditions, so that much higher combined cycle efficiencies can be reached. This scheme is applied to the case of an advanced fuel proton-boron 11 fusion reactor using a single reheat topping and bottoming cycle. A wide variety of possible working fluid combinations are considered and particular cycle calculations for the thermal efficiency are presented. The operation of the radiation boiler and energy exchanger are both described. Material compatibility, x-ray absorption, thermal hydraulics, structural integrity, and other technical features of these components are analyzed to make a preliminary assessment of the feasibility of this concept.

INERTIAL CONFINEMENT SYSTEMS

REFER ALSO TO CITATION(S) 10790, 10865, 11196

11349 (EPRI-ER—536-SR, pp 123-131) **Implosion of advanced fuels using high energy heavy ions.** Martin, R.L. (Argonne National Lab., IL). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

The use of high energy heavy ions for igniting the fusion reaction in DT pellets appears most promising. It is relatively simple to extend this concept to the implosion of pellets of advanced fuels. An accelerator configuration designed for DT fusion would clearly test advanced fuel pellets in a meaningful way. To obtain useful output power from the catalyzed D reaction, and likely from D-^{3}He, appears to require a high accelerator efficiency. This requirement limits the choices of accelerator configurations to that of a full energy linac filling several storage rings. The feasibility of meeting the requirements appears quite high. The trend raises the question, yet unanswered, concerning the potential for obtaining useful output powers from more exotic fuels such as P-^{11}B.

11350 (EPRI-ER—536-SR, pp 153-165) **Laser-fusion employing direct nuclear pumped lasers and advanced fuel (D-D-T) pellets.** Miley, G.H.; Choi, C.K. (Univ. of Illinois, Urbana). Sep 1977.

From EPRI review meeting on advanced fuel fusion; Chicago, Illinois, USA (27 Jun 1977).

In Proceedings of the review meeting on advanced-fuel fusion.

Direct Nuclear Pumped Lasers (DNPLs) that employ neutrons to pump gas lasers by creating MeV-charged particles through nuclear reactions in the laser cavity have been demonstrated experimentally. It is potentially attractive to use neutrons from a fusion-pellet microexplosion to pump the laser since this avoids the inefficiencies and cost of converting the neutron energy to electrical energy as required for conventional lasers. A deuterium-rich advanced fuel (D-D-T) pellet is especially attractive since the reduction in tritium breeding requirements provides more freedom in blanket design, making more neutrons available for pumping the DNPL. Indeed, preliminary calculations suggest that adequate neutrons can be obtained for a successful laser-feedback device.

11351 (UCRL—79816) **Performance of Argus as a laser fusion facility.** Speck, D.R.; Simmons, W.W.; Hunt, J.T.; Boyle, M.J.; Rainer, F.; Storm, E.K.; Swift, C.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Sep 1977. Contract W-7405-ENG-48. 33p. (CONF-770945—3). Dep. NTIS, PC A03/MF A01.

From 11. European conference on laser interaction with matter; Oxford, UK (19 Sep 1977).

During the fifteen months that the Argus laser facility has been operating we have had two primary goals. These are: (1) to provide focusable, well characterized, high power beams for laser fusion experiments and (2) to further understand the propagation of high power and energy pulses. The propagation experiments have already led to increases in the laser output power and system reliability. Pulses appropriate for advanced targets are shaped to optimize the compression and heating of the target. In general they stress the laser in both limits of energy and power. In this work several results significant to the laser fusion program were realized. The neutron output of fusion targets increased by almost two orders of magnitude to more than 10^{9} neutron/shot. An improved beam propagation technique (image relaying) was developed and partially implemented. It increased the focusable output power for short pulses (30-100 ps) to more than 4.0 TW. More than one kilojoule/beam was extracted from the laser in a high quality beam in a one nanosecond Gaussian pulse. A complex two step optical pulse was generated and successfully amplified to peak powers of more than 3.0 TW. The most recent of the system upgrades are complete image relaying and improved "C" laser disk edge coatings which are presently being implemented. These changes will further improve laser and target performance.

11352 (UCRL—79819) **Laser fusion implosion and plasma interaction experiments.** Ahlstrom, H.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1977. Contract W-7405-ENG-48. 139p. (CONF-770947—1; CONF-770945—4). Dep. NTIS, PC A07/MF A01.

From CECAM meeting on models for transport phenomena in laser fusion plasmas; Menton, France (5 Sep 1977).

Results related to the propagation, absorption and scattering of laser light by both spherical and planar targets are described. The absorption measurements indicate that for intensities of interest, inverse bremsstrahlung is not the dominant absorption mechanism. The laser light scattered by the plasma is polarization dependent and provides evidence that Brillouin scattering and resonance absorption are operative. Special diagnostics have been designed and experiments have been performed to elucidate the nature of these two processes. Implosion results on glass microshell targets filled with DT gas are also summarized. These experiments are for targets intentionally operated in the portion of parameter space characteristic of exploding pusher events. Experiments have been performed over a yield range from 0 to 10^{9} neutrons per event. It is shown how this data can be normalized with a simple scaling law.

11353 **Lasers for nuclear fusion.** Klose, E. (Akademie der Wissenschaften der DDR, Berlin. Zentralinstitut fuer Optik und Spektroskopie). *Tech. Inf. GRW;* **25**: No. 7, 21-23(Jul 1977). (In German).

Fundamentals of laser fusion are presented and the current status of USSR's corresponding research work is described. Consideration is given to the need for effective conversion of the energy of neutrons and alpha particles being formed in thermonuclear reactions. A hybrid fission/fusion system is compared with a fusion system and the most significant parameters of a laser fusion reactor are given.

11354 **Population inversions for soft X-ray transitions computed for rapidly cooling plasmas.** Tallents, G.J. (Australian National Univ., Canberra. Dept. of Engineering Physics). *J. Phys., B (London);* **10**: No. 9, 1769-1780(21 Jun 1977).

Population densities of excited and ground states of hydrogen-like ions have been computed on a time-dependent basis for an initially steady-state plasma in which the electron temperature subsequently decays exponentially with a half-life sufficiently short (approximately 10^{-13}s) to produce population inversions with respect to the ground state. The principal results are for $Z = 6$ (carbon), initial electron temperature 200 eV and electron density 10^{21} cm^{-3}, though variations in these parameters are considered. The results are related to cooling rates in expanding plasmas as predicted by (i) the one-dimensional numerical code MEDUSA, and (ii) a simple model of cooling at the centre of an expanding plasma. Reference is made to laser-produced plasmas.

11355 **Lagrangian versus an Eulerian framework in laser fusion processes.** LoDato, V.A. (Simulating Science and Engineering, Wappingers Falls, N.Y. (USA)). *Atomkernenergie;* **29**: No. 3, 229(1977).

11356 **Formation, propagation, and structure of laser supported detonation waves and their effect on laser-target interactions.** Richard, M.R. Lincoln; Univ. of Nebraska (1976). 186p. University Microfilms Order No. 77-14,693.

Thesis (Ph. D.).

A computer model is used to examine in detail the nonequilibrium structure and propagation mechanisms of laser supported detonation waves, and the heating of a metal target in the presence of a plasma. An important feature of this model is that it includes not only the one-dimensional hydrodynamic flow of the plasma, but also describes its microscopic nonequilibrium behavior within the laser field. In order to do this the plasma is treated as a four-component gas consisting of ground state atoms, excited state atoms, singly charged ions and electrons, with the electrons and heavy particles having separate temperatures. Chnages in the number densities of these species and in their temperatures are brought about by absorption of laser radiation, and elastic, inelastic and superelastic collisions between electrons and heavy particles, as well as by electron thermal conduction, radiation transport and ambipolar diffusion. This model gives laser-induced breakdown times for helium, argon and air which agree well with those obtained by detailed quantum kinetic calculations of gas breakdown over a wide range of laser intensities.

COMPONENT DEVELOPMENT AND TESTING

11357 (WFPS-TME—007) **TFTR central instrumentation and control philosophy.** Walsh, J.M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Oct 1975. Contract EY-76-C-02-3073. 32p. Dep. NTIS, PC A03/MF A01.

This report documents a conceptual study performed to develop a central instrumentation and control philosophy for the TFTR facility. This study addresses the following questions: (1) What are the various control and monitoring functions involved. (2) How many and what different kinds of qualified operating personnel are to be provided. (3) How are the various control and monitoring functions, and as a result the control personnel, to be assigned to the central control station. (4) How is the crucially important experimental data handling, processing, and analysis function to be interfaced with the facility control functions. (5) What modes require back shift operating personnel. In this report the present central control operating philosophy is stated with discussion of the principle underlying its choice. The report is organized so that the statement of control philosophy is given in one paragraph, and the basis for this choice is given in the following paragraph. Each statement of the control philosophy addresses one of the specific questions above.

11358 (WFPS-TME—026) **TFTR magnetic field design analyses.** Davies, K.; Iwinski, E.; McWhirter, J.M. (Westinghouse Electric

Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Nov 1975. Contract EY-76-C-02-3073. 62p. Dep. NTIS, PC A04/MF A01.

The three main magnetic field windings for the TFTR are the toroidal field (TF) windings, the ohmic heating (OH) winding, and the equilibrium field (EF) winding. The following information is provided for these windings: (1) descriptions, (2) functions, (3) magnetic designs, e.g., number and location of turns, (4) design methods, and (5) descriptions of resulting magnetic fields. This report does not deal with the thermal, mechanical support, or construction details of the windings.

11359 (WFPS-TME—028) **Sequence of operations: TFTR assembly and disassembly.** Francy, W.J.; Lampe, R. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Dec 1975. Contract EY-76-C-02-3073. 47p. Dep. NTIS, PC A03/MF A01.

A conceptual sequence of operations necessary to complete initial assembly of the Tokamak Fusion Test Reactor (TFTR) are described along with subsequent disassembly operations and special techniques planned for use during radioactive disassembly. Special attention is given in this report to techniques, personnel exposure, and equipment needed to effect the opening and closing of a vacuum vessel port and the installation of the vacuum vessel seal weld cutting machine under radioactive conditions.

11360 (WFPS-TME—030) **Conditioning of the vacuum vessel walls of tokamaks, a preliminary look.** Sink, D.A. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Mar 1976. Contract EY-76-C-02-3073. 26p. Dep. NTIS, PC A03/MF A01.

The main features and operating characteristics of the primary vacuum system of many of the presently operating tokamak devices are presented. Particular attention is paid to the methods used to condition and clean the vessel walls in situ. For the devices discussed, a combination of a high-temperature bakeout and/or discharge cleaning is employed. In addition, discussions of the vacuum systems and wall conditioning methods anticipated for the next generation of tokamaks are presented. Since this report was written during a limited time period, it should be considered as preliminary and is not intended to be a general review. Much of the information that is presented was obtained by private communication and there is no bibliography. This study was initiated to aid in the design of TFTR. As presently envisioned, the TFTR vacuum system and methods for wall conditioning are consistent with what is presently practiced.

11361 (WFPS-TME—031) **Compilation of TFTR materials data.** Havener, W.J. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Dec 1975. Contract EY-76-C-02-3073. 262p. Dep. NTIS, PC A12/MF A01.

In order to document the key thermophysical property data used in the conceptual design of Tokamak Fusion Test Reactor (TFTR) systems and components, a series of data packages has been prepared. It is expected that data for additional materials will be added and the information already provided will be updated to provide a project-wide data base.

11362 (WFPS-TME—032) **Experimental studies of zirconium/aluminum getter pumps.** Lange, W.J. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Dec 1975. Contract EY-76-C-02-3073. 30p. Dep. NTIS, PC A12/MF A01.

Getters of the type to be utilized as tritium pumps in the foreline of the TFTR torus vacuum system, and presumably in those of the neutral beam injector arms, were evaluated using hydrogen and deuterium. The capacity and speed as rated by the manufacturer (SAES) are found to be conservative. In addition, the getters are shown to continue to pump hydrogen even in the presence of chemically active, impurity gases, provided the getter temperature is maintained at $>300^{0}$C. Since hydrogen pumping is reversible, the getters can be used over and over again after reactivation to release the previously pumped hydrogen. By operating a tungsten filament to crack methane, and using the getter to pump the hydrogen produced, relatively high speed and capacity for methane is demonstrated.

11363 **Resonant helical divertor.** Karger, F.; Lackner, K. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). *Phys. Lett., A;* **61**: No. 6, 385-387(13 Jun 1977).

A concept for a helical divertor is proposed, which utilizes a resonance effect, and reduces the required divertor currents to a small fraction (typically 10^{-2}) of the plasma current. This divertor should have a larger screening efficiency than the poloidal field divertor, and could operate with divertor coils outside the vacuum vessel or the blanket.

11364 **Spectra of highly ionized molybdenum and heavy elements provided for fusion diagnostics.** Reader, J.; Sugar, J. *Dimensions/NBS;* 25-26(Jun 1977).

NBS physicists have measured the main spectral lines of the ions Mo^{+12} and Mo^{+13} in the far-vacuum ultraviolet range, 10 to 50 nm. Related NBS measurements have given needed wavelength identifications for several different ions of Ta, W, Re, Pt, Au, and Hg up through Hg^{+12}, which are also of interest. These data are being used by fusion scientists to diagnose important impurities that limit the performance of controlled thermonuclear reactors such as Tokamak devices. A recent ERDA review of work in this field described the results as "very important" for CTR diagnostics.

11365 **Device for supporting a vacuum container for a toroidal nuclear fusion apparatus.** Sato, K.; Wase, K. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-137097/A/. 23 May 1975. 3p. (In Japanese).

Object: To support a vacuum container at a high level with accuracy and securely without giving damage and in a manner capable of being escaped from thermal expansion and adjusted in position. Structure: An adjusting liner is interposed between a spacer for supporting one side of a vacuum container and an external support and a resilient member is interposed between a spacer for supporting the other side of the vacuum container and the external support.

11366 **Ceramic dielectric type vacuum container.** Yamada, M.; Taguchi, M. (to Mitsubishi Atomic Power Industries, Inc., Tokyo (Japan)). Japanese Patent 1976-116399/A/. 4 Apr 1975. 4p. (In Japanese).

Object: To cut off an induced current generated in a ceramic dielectric type vacuum container for a plasma containment device, thereby enhancing plasma efficiency and preventing generation of electromagnetic interactions in the vacuum container and between coils. Structure: Between a plurality of vacuum container elements and a ceramic dielectric body inserted therebetween are formed a sealing device and a secondary vacuum chamber through a bellows made of more than two materials different in coefficient of thermal expansion, whereby the vacuum container elements are electrically insulated from one another to restrain an electric current within the vacuum container induced by the plasma and exerting a fastening force resulting from the difference in thermal expansion of the bellows at the time of high temperature upon between the container elements and the dielectric body to maintain ultrahigh vacuum within the container.

11367 **Method for mounting a magnetic limiter.** Yamada, M.; Nishikawa, M. (to Mitsubishi Atomic Power Industries. Inc., Tokyo (Japan)). Japanese Patent 1976-114598/A/. 2 Apr 1975. 3p. (In Japanese).

Object: To reduce by half even stress due to thermal expansion produced in a magnetic limiter. Structure: A magnetic limiter is secured to a bed in a state where it is heated between the operative temperature and the inoperative temperature and installed within a vacuum container. Heating means include a method for flowing high temperature water such as warm water into coolant passage.

11368 **Whole peripheral limiter in a plasma generator.** Yamada, M. (to Mitsubishi Atomic Power Industries, Inc., Tokyo (Japan)). Japanese Patent 1976-114597/A/. 2 Apr 1975. 4p. (In Japanese).

Object: To enable measuring an image current generated by plasma and easily taking it out of linear of a vacuum container. Structure: A lower plate is mounted on the outer surface of liner, that is, on the surface close to the wall of vacuum container by means of a first bolt inserted into an insulating member made of an electric insulating material such as alumina, and a portion between the liner and the lower plate is electrically insulated by a first spacer made of alumina or the like. Into an opening made in the liner is inserted a second spacer, one end of which is in contact with the lower plate whereas the other end having a doubling plate insulated from the liner. A whole peripheral limiter is secured to the surface of the doubling plate on the interior side of the vacuum container. Therefore, by connecting a suitable lead wire to the lower plate, the image current generated in the whole peripheral limiter by the plasma may easily be taken out of the vacuum container for measurement.

11369 **Bellows means for vacuum container in plasma producing apparatus.** Nishikawa, M.; Aizawa, T.; Yamada, M.; Taguchi, M. (to Mitsubishi Atomic Power Industries, Inc., Tokyo (Japan)). Japanese Patent 1976-108200/A/. 20 Mar 1975. 4p. (In Japanese).

Object: To provide a bellows means, which permits uniform heating efficiently and can be readily maintained and manufactured, by providing the outer periphery of an annular bellows having ridges and grooves with a close arrangement of a plurality of insulating refractory blocks where a sheath heater provided with heat transfer plate means is embedded. Structure: A bellows means, the outer periphery of which has ridges and grooves and is provided with a close arrangement of a plurality of insulating refractory blocks having ridges and grooves, a sheath heater and heat transfer plate means connected thereto being embedded in the blocks.

11370 Fabrication of annular bellows type containers. Uchida, T.; Aida, H. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-106900/A/. 18 Mar 1975. 3p. (In Japanese).

Object: To produce substantially toroidal bellows type containers by simply welding and assemblying a multitude of bellows members. Structure: An annular container composed of bellows, wherein bellows members divided in the circumference are formed by a press with pitch in the inner periphery of each of said members made smaller than that of the outer periphery thereof, said members being welded and assembled annularly.

11371 Vacuum problems in plasma physics and controlled nuclear fusion. Prevot, F. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee). *Jpn. J. Appl. Phys.;* No. Supp. 2-1, 225-231(1974).

From 6. international vacuum congress; Kyoto, Japan (25 Mar 1974).

Vacuum problems in CTR involve a number of new aspects which make them different and often more difficult and complex than in any other fields of application. The first important aspect is the existence of the plasma itself which is at the same time a large source of neutral gas and a powerful internal pump. Interaction between neutral gas and plasma is very different whether the plasma is transparent or opaque to neutral atoms or molecules. The second important aspect is the influence of the walls on plasma pollution by high Z atom induced emission. These two phenomenons play an important role in the energy balance of both laboratory plasmas and future thermonuclear reactors. Concerning the vacuum system of thermonuclear reactor, the enormous size of the vessel and pumping speed requested and some safety problems inherent to tritium handling and neutron activation must be specially mentioned. Several solutions have been proposed and partially tested in present experiments: choice of the material of the wall, baking and surface processing, pumping and auxiliary equipments, magnetic divertor and protective layer of cold plasma. Examples of typical cases will be presented and discussed.

11372 Vacuum chamber of a tokamak plasma experiment(TFR). Sledziewski, Z.; Huguet, M.; Rebut, P.H.; Torossian, A. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). *Jpn. J. Appl. Phys.;* **Suppl. 2-1**: 217-220(1974).

From 6. international vacuum congress; Kyoto, Japan (25 Mar 1974).

The magnetic confinement of hot plasmas needs high quality vacuum chambers. The bombardment of the walls by particles (ions, electrons, fast atoms, photons, neutrons) must not involve a large flux of secondary emission products. This report describes the realization of a vacuum chamber needful for a toroidal plasma confinement experiment of Tokamak type (TFR). The geometric characteristics of the torus are: major radius 0.98 m, minor radius 0.20 m, volume of the chamber and observation ports: 1.5 m^3, total surface: 35 m^2. The vacuum vessel is made of a series of belows of inconel x750, 0.5 mm thick; it is bakable up to 450°C. The assembling of each toroidal section with the observation ports is obtained by electron-bombardment welding. The pumping circuit consists of a primary pump and two turbo-molecular pumps in series (600 l/s and 70 l/s). Two 0.5 m^2 titanium pumps, cooled at liquid nitrogen temperature, are also used in parallel with the turbo-molecular pumps in order to increase the pumping speed between two plasma discharges. The base pressure obtained after baking the chamber itself at 420°C and the observation sections at 200°C is 5.10^{-10} Torr. The mean outgassing rate of the walls is then 2.10^{-13} Torr l/s.cm^2.

GENERAL AND MISCELLANEOUS

11373 (UCID—17602) **Hydrodynamic effects of laser beams slewed at transonic velocities through the atmosphere.** Edwards, A.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1977. Contract W-7405-ENG-48. 33p. Dep. NTIS, PC A03/MF A01.

The hydrodynamic effect of a laser beam slewed through the atmosphere is treated by various approximations which are singular or invalid near Mach 1. A modified linear solution which is valid for transonic slewing velocities is presented for the one-dimensional case. This solution predicts the density, pressure, and material velocity changes at fully developed flow, in good agreement with numerical nonlinear hydrodynamics calculations. The form of the fully developed flow solution changes discontinuously as the absolute slewing velocity increases, from a shock wave upwind of a locally subsonic source, to an expansion wave downwind of a locally supersonic source. The maximum density and other changes occur in the shock wave solution, at the transition velocity, and are proportional to the square root of the total source strength. The transient behavior leading to the fully developed flow solution is qualitatively described. The steady state form of the modified linear solution is shown to be an approximation to a nonlinear steady state solution, provided the local Mach number used in the latter solution is properly interpreted in terms of the absolute slewing velocity and the initial sound speed in the undisturbed medium. The properties of the one-dimensional case have important implications for the two-dimensional case. The solution of the two-dimensional case is necessary for the calculation of the effects of thermal blooming on the propagation of high powered laser beams through the atmosphere.

MANAGEMENT

REFER ALSO TO CITATION(S) 11382, 11384

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 11036

11374 (CONF-770525—) **Proceedings: AESOP conference. Volume 16.** (Energy Research and Development Administration, Washington, D.C. (USA)). 1977. 152p. Dep. NTIS, PC A08/MF A01.

From 16. AESOP conference; Seattle, Washington, USA (2 May 1977).

Separate abstracts were prepared for three of the papers in these proceedings. Six other papers have already been cited in ERA and entered into the data base; these papers may be identified by consulting the entry CONF-770525— in the Report Number Index. (RWR)

11375 (CONF-770525—, pp 1-17) **ERDA/ADP procurement trends.** Logerwell, R. 1977.

From 16. AESOP conference; Seattle, Washington, USA (2 May 1977).

In Proceedings: AESOP conference. Volume 16.

The contracting-out philosophy of the federal government in general and ERDA in particular is reviewed. The basic guidelines are set forth in A-76. The purposes of the Brooks Bill and aspects of the regulation process are discussed. Requests for proposal are explained. Current issues treated include the following: augmentation vs replacement, used equipment, alternate payment plans, separate charges, unbalanced prices, free offers, functional specifications, class VI techniques, and protests. (RWR)

11376 (CONF-770689—) **Inductive modelling of population time series.** Rust, B.W.; Kirk, B.L. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 52p. Dep. NTIS, PC A04/MF A01.

From SIMS conference on statistical analysis of ecological processes in time and space; Alta, Utah, USA (27 Jun 1977).

A method for modeling time series is considered which is based on the iterative combination of statistical regression and spectral analysis techniques. The goal is to find a model which reduces the residuals to a white noise series. The use of the technique is illustrated by considering two examples: striped bass catch curves for the Atlantic coast fisheries, and the time series for the buildup of CO_2 in the atmosphere. Finally, the application of the technique to the 10-year wildlife cycle is briefly discussed. 12 figures, 4 tables.

11377 (CONF-770740—) **Proceedings: AESOP conference.** (Department of Energy, Washington, D.C. (USA)). 1977. 265p. Dep. NTIS, PC A12/MF A01.

From AESOP operations managers conference; Arlington, Virginia, USA (11 Jul 1977).

A separate abstract was prepared for each of the fourteen papers in this report. (RWR)

11378 (CONF-770740—, pp 1-20) **Trends in ADP technology and standards.** Meissner, P. 1977.

From AESOP operations managers conference; Arlington, Virginia, USA (11 Jul 1977).

In Proceedings: AESOP conference.

The emphasis in the next generation of computers is toward distributed systems having multiple, specialized processors. This trend is exemplified in the "intelligent" terminal, "personalizing" of computers such as the pocket calculator and time-sharing terminal, use of time-shared computers to prepare object code for a local microprocessor. Closely knit hardware and software design will conceal from the user machine idiosyncrasies and result in built-in error correction provisions. The number of logic gates which fit on a single Si chip is projected to increase from 3000 in 1975 to 250,000 in 1981. Improved storage devices will be based on magnetic bubbles, charge-coupled devices, or electron-beam accessed memory; mass storage will be accomplished through optical storage devices (using

laser beams and possibly holograms) and magnetic cartridges. Fiber optics for wide-bandwidth, high-frequency communication, storage management processors, networks and distributed processing, and computer security are also considered. 3 figures. (RWR)

11379 (CONF-770740—, pp 21-36) **ERDA/ADP procurement.** Logerwell, R. (Energy Research and Development Administration, Washington, DC). 1977.

From AESOP operations managers conference; Arlington, Virginia, USA (11 Jul 1977).

In Proceedings: AESOP conference.

Four topics are discussed: the paperwork necessary to initiate a procurement (including specifications, evaluation criteria, and special proposal instructions); involvement of ERDA procurement with GSA with respect to ADPE; the package prepared by procurement people for the marketplace (RFP standards and contents--specifications, evaluation criteria, award formula, terms and conditions); and steps from RFP release to award--publication in Commerce Business Daily, RFP, preproposal conference, RFP close, mandatory evaluation, competitive range and benchmarks, discussion, complete evaluation/final offers, selection, and award. 5 figures. (RWR)

11380 (CONF-770740—, pp 37-53) **ADP operations audits.** Sotos, G. 1977.

From AESOP operations managers conference; Arlington, Virginia, USA (11 Jul 1977).

In Proceedings: AESOP conference.

Operational auditing is discussed. It is felt that governments and agencies entrusted with public resources and the authority for applying them have a responsibility to render a full accounting of their activities. Three types of audits considered are financial and compliance audits, economy and efficiency audits, and program results audits (including examination of possible alternatives). Many of the checks done by auditors should routinely be done by ADP managers as a regular part of quality control. 9 figures. (RWR)

11381 (CONF-770740—, pp 73-95) **DMA computer plans.** Purtee, K. 1977.

From AESOP operations managers conference; Arlington, Virginia, USA (11 Jul 1977).

In Proceedings: AESOP conference.

Computer acquisition as seen from the point of view of a funding officer is discussed. The cycle between determination of computer needs and Congressional appropriation is presented. Various aspects of budgets for several years are being handled simultaneously. (RWR)

11382 (CONF-770740—, pp 96-140) **Questionnaire review and discussion.** 1977.

From AESOP operations managers conference; Arlington, Virginia, USA (11 Jul 1977).

In Proceedings: AESOP conference.

As a result of a questionnaire, this discussion dealt with personnel rotation, career opportunities, performance evaluation, and disaster planning/backup facilities. A few summarizing statements are made. Documents dealing with personnel and catastrophe recovery furnished by SLA are included. (RWR)

11383 (CONF-770740—, pp 141-145) **Operations Open Book. Session III.** 1977.

From AESOP operations managers conference; Arlington, Virginia, USA (11 Jul 1977).

In Proceedings: AESOP conference.

A panel considered the methods and degree of user participation in influencing computer operations. Discussion points included the following: amount of information on computer operations furnished to the user community; determination of user information needs and what information to supply; methods used to disseminate information; measurements of services to users; advisability of guidance committees. (RWR)

11384 (CONF-770740—, pp 146-165) **Impact of telecommunications on computer operations management.** Allen, C.L. (Union Carbide Corp., Oak Ridge, TN). 1977.

From AESOP operations managers conference; Arlington, Virginia, USA (11 Jul 1977).

In Proceedings: AESOP conference.

Consideration of a multicomputer, multisite computer facility leads to the conclusions that operations are definitely impacted by and heavily dependent on telecommunications, and that it would be impossible to meet the objectives of today fully without telecommunications. Areas of particular impact of telecommunications on computer operations management are physical resources, security and policing, resource utilization, and public relations. 10 figures. (RWR)

11385 (CONF-770740—, pp 166-184) **Future of computer operations: distributive processing.** Smith, J.P. 1977.

From AESOP operations managers conference; Arlington, Virginia, USA (11 Jul 1977).

In Proceedings: AESOP conference.

Distributive processing means locating individual processors (usually minis) in locations remote from central headquarters and letting these processors do the major processing of given applications. Reasons for a change in concepts with respect to computers are discussed: what is being given up. Is the new setup operationally effective. Is it cost effective. The author feels that the question is not so much whether distributive processing concepts are valid, but whether they are appropriate for a specific situation. The key is cost and user satisfaction. Personal experiences and opinions of a DP manager are related. 5 figures. (RWR)

11386 (CONF-770740—, pp 185-207) **Impact of DBMS on computer operations.** Katonak, P. 1977.

From AESOP operations managers conference; Arlington, Virginia, USA (11 Jul 1977).

In Proceedings: AESOP conference.

Data base management systems are discussed with particular emphasis on their impact on operations. An introductory background is given on DBMS and traditional vs DBMS processing. Problems related to DBMS operation include data base control, DBMS support, location of the DBA, and DBMS implementation. The Savannah River Laboratory approach to DBMS is examined with respect to selection history, organizational considerations, and implementation plan. Experience in relation to background training requirements, system support time, and operational factors is set forth. It is concluded that a conservative application of ADABAS with the DBA function assigned to the Operations Division was a good one. 15 figures. (RWR)

11387 (CONF-770740—, pp 208-231) **Workload scheduling and production control.** Dean, A.E. 1977.

From AESOP operations managers conference; Arlington, Virginia, USA (11 Jul 1977).

In Proceedings: AESOP conference.

The outline (rather than full-sentence text) of a discussion on workload scheduling and production control is given. It covers the following topics: necessity for workload control (introduction, evolution of need); immediate benefits of production control (resource commitment visibility, processing/product accountability, performance measurement tools); major elements of production control (workload forecasting, status reporting, performance reporting, problem evaluation); workload forecasting components (initial phase considerations, development phase tasks, maintenance phase objectives); status reporting goals; performance measurement criteria; problem evaluation; costs; benefits of this approach (establishment of credible forecasting for negotiation with users, improved on-time performance, objective problem resolution). 14 figures. (RWR)

11388 (CONF-770740—, pp 232-240) **Overview of performance measurement.** Kiviat, P.J. (Federal Computer Performance Evaluation and Simulation Center, Washington, DC). 1977.

From AESOP operations managers conference; Arlington, Virginia, USA (11 Jul 1977).

In Proceedings: AESOP conference.

Viewgraphs for a talk on performance measurement are presented. They summarize the main points of the talk: typical project objectives (computer/communications systems selection, computer capacity, software analysis, operations analysis, special-purpose computer systems design); agency concerns that lead to typical FEDSIM projects (computer procurement, computer sizing, performance measurement, computer center operations review, system performance prediction, computer center management). In summary, emphasize performance, not measurement; take a total systems approach; and develop a good management reporting system. (RWR)

11389 (CONF-770740—, pp 241-254) **Performance measurement.** Townsend, D. 1977.

From AESOP operations managers conference; Arlington, Virginia, USA (11 Jul 1977).

In Proceedings: AESOP conference.

A history of computer scheduling at the Rocky Flats Plant is given. Originally, it was handled by the computer operators; then, by a single scheduler (human). At present, a software scheduling system is used. It took over a year to get all the required information into the data base. The facilities and flexibility of the present system are described, and future plans are outlined. 9 figures. (RWR)

11390 (CONF-770740—, pp 255-261) **Use of performance measurement data in the Livermore timesharing system.** Werner, R.G. (Univ. of California, Livermore). 1977.

From AESOP operations managers conference; Arlington, Virginia, USA (11 Jul 1977).

In Proceedings: AESOP conference.

Components at the computer center at LLL are briefly described. The interconnected system can be characterized as a bid-priority-driven timesharing system with almost no system-imposed limitors as to what resources a user can have or how to use them. System performance is continuously monitored by means of three

pictures available to all users through the television monitor display system. These show a block diagram of the system showing whether each data interface is working, the current status of each host and concentrator, and lists of all jobs in the queue and system utilization. These performance probes enable both users and operations personnel to employ the computers more efficiently. 3 figures. (RWR)

11391 (LA—6920-M) **System for histogram entry, retrieval, and plotting.** Kellogg, M.; Gallup, J.M.; Shlaer, S.; Spencer, N. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-36. 32p. Dep. NTIS, PC A03/MF A01.

This manual describes the systems for producing histograms and dot plots that were designed for use in connection with the Q general-purpose data-acquisition system. These systems allow for the creation of histograms; the entry, retrieval, and plotting of data in the form of histograms; and the dynamic display of scatter plots as data are acquired. Although the systems are designed for use with Q, they can also be used as a part of other applications. 3 figures.

11392 (LA—6958-MS) **ANSWER: a general purpose question answering system.** Schultz, D.E. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36. 43p. Dep. NTIS, PC A03/MF A01.

ANSWER is a set of computer programs that allows a reference on virtually any topic to be "indexed" so that natural language questions can be used to select a portion of the reference. The selected part of the reference is then displayed at a terminal as the "answer" to the question. This general purpose tool appears to have use wherever questions need to be answered on relatively stable reference material. 6 figures.

11393 (LA-UR—77-2383) **Scientific calculating system with a number-oriented microprocessor sequenced by a single component microcomputer.** Ethridge, C.D.; Worth, G.M. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 5p. (CONF-771023—5). Dep. NTIS, PC A02/MF A01.

From Nuclear science symposium; San Francisco, California, USA (19 Oct 1977).

A scientific calculating system for large distributed-task processing systems and for small isolated intelligent data acquisition and instrumentation systems is established with a number-oriented microprocessor sequenced by a single-component microcomputer. A MOS/LSI number-oriented microprocessor provides the scientific calculating capability with Reverse Polish Notation data entry. Input data sequencing, computation processing, intermediate result comparison, answer display and/or answer feed-back to master processors is controlled by a single-component microcomputer. 3 figures, 1 table.

11394 (LA-UR—77-2521) **Examples of maximum likelihood spatial filtering.** Lahart, M.J. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 4p. (CONF-771104—3). Dep. NTIS, PC A02/MF A01.

From 11. annual ASILOMAR conference on circuits, systems, and computers; Pacific Grove, California, USA (7 Nov 1977).

A maximum-likelihood method for estimating spatial frequency components of truncated sections of data is described. The method is used to estimate the one-dimensional Fourier transform of short scans of images of an edge and of a slit. With the aid of a constrained least-squares noise control, the frequency response of the imaging system is computed from the estimated Fourier transform.

11395 (ORNL/CSD/TM—41) **PLOT user's manual.** Lynch, S.J.; Holmes, J.A. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36. 71p. Dep. NTIS, PC A04/MF A01.

PLOT, a plotting routine currently available on the Livermore Time-Sharing System, uses dd80 calls to produce standard x-y plots and contour plots with one user call. The contour plots can be in Cartesian or polar coordinates. Although PLOT has no provisions for general contour plotting, the user can define his own coordinate system if he so chooses. PLOT creates graphic output having a good appearance, and provides axes, labeling, scaling, and positioning. A vector plotter is also available in PLOT. This easily used subroutine has options for multiple curves on one plot or multiple plots on one page. PLOT (in LRLTRAN source code) is available on the 7600 in FILEM area 24730 .SUE PLOT. 1 figure.

11396 (ORO—3443-68) **A-posteriori error estimates for the finite element method. Technical report TR-581.** Babuska, I.; Rheinboldt, W.C. (Maryland Univ., College Park (USA). Computer Science Center). Sep 1977. Contract EY-76-S-05-3443. 38p. Dep. NTIS, PC A03/MF A01.

Computable a posteriori error estimates for finite-element solutions are derived in an asymptotic form for $h \to 0$ where h measures the size of the elements. The approach has similarity to the residual method, but differs from it in the use of norms of negative Sobolev spaces corresponding to the given bilinear (energy) form. For clarity the presentation is restricted to one-dimensional model problems. More specifically, the source, eigenvalue, and parabolic problems are considered involving a linear, self-adjoint operator of the second order. Generalizations to more general one-dimensional problems are straightforward, and the results also extend to higher space dimensions; but these invlove some additional considerations. The estimates can be used for a practical a posteriori assessment of the accuracy of a computed finite-element solution, and they provide a basis for the design of adaptive finite-element solvers.

11397 (ORO—5046-5) **Algorithm for nonparametric density estimation.** Scott, D.W.; Tapia, R.A.; Thompson, J.R. (Baylor Univ., Houston, Tex. (USA). Coll. of Medicine; Rice Univ., Houston, Tex. (USA). Dept. of Mathematical Sciences). 1976. Contract EY-76-S-05-5046. 6p. Dep. NTIS, PC A02/MF A01.

A numerical algorithm is given for implementing a nonparametric maximum penalized likelihood estimator similar to those proposed by Good and Gaskins [Biometrika, 58, 255-77(1971)] and those proposed by de Montricher, Tapia, and Thompson [Ann. Statistics, 3, 1329-48(1975)]. It is shown how the resulting nonlinear constrained optimization problem may be effectively solved by using Tapia's approach to Newton's method for constrained problems. 6 figures, 1 table.

11398 (RS—8323/104) **6600 user's manual.** Isler, R.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jan 1975. Contract EY-76-C-04-0789. 332p. Dep. NTIS, PC A15/MF A01.

This manual is a user's reference manual describing the more commonly used control cards and features of the SCOPE operating system for the CDC 6600 computer, and the additions and changes to SCOPE which are unique to the SLL 6600.

11399 (RS—8441/10) **APT part programming checklist.** Quock, H. (Sandia Labs., Albuquerque, N.Mex. (USA); Sandia Labs., Livermore, Calif. (USA)). Dec 1973. Contract EY-76-C-04-0789. 29p. Dep. NTIS, PC A03/MF A01.

The material presented here was prepared as a reference guide for APT part programers.

11400 (SAND—77-1507C) **Update on CAD/CAM activities at Sandia Laboratories.** Oliver, D.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1977. Contract EY-76-C-04-0789. 28p. Dep. NTIS, PC A03/MF A01.

Development of systems for Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) has been underway at Sandia Laboratories for several years. These include systems for circuit design and analysis, systems for design and fabrication of printed circuit boards and hybrid microcircuits, and systems for mechanical applications, such as mass properties calculations and stress analysis. CAD/CAM operations have proved successful for electronic applications. Current emphasis is on development of mechanical support software, and with putting into production a machine-aided design and definition system (MADDS) utilizing Applicon Graphics Systems (AGS). 14 figures. (RWR)

11401 (UCID—30131(Rev.1)) **GOOF: OCTOPUS error messages, ORDER, ORDERLIB, FLOE, CHAT, and LOD.** Whitten, G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Jul 1977. Contract W-7405-ENG-48. 81p. Dep. NTIS, PC A05/MF A01.

This is a compilation of the error messages returned by five parts of the Livermore timesharing system: the ORDER batch-processor, the ORDERLIB subroutine library, the FLOE operating system, the CHAT compiler, and the LOD loader.

11402 (JPRS—69880) **Translations on USSR science and technology: Physical Sciences and Technology No. 19.** 28 Sep 1977. Translation of USSR articles. 34p. NTIS.

An abstract was prepared on one of the four papers included. Three of the papers were not within the scope of ERA. (WHK)

11403 **Bivariate model for the distribution of $\sqrt{b_1}$ and b_2.** Shenton, L.R. (Univ. of Georgia, Athens); Bowman, K.O. *J. Am. Stat. Assoc.*; 72: No. 357, 206-211(Mar 1977).

In sampling from general populations, the skewness and kurtosis statistics are subject to the constraint $b_2 > 1 + b_1$. A bivariate product-density model for the distribution of $\sqrt{b_1}$ and b_2 is studied, consisting of a Johnson S/sub U/ approximation to the marginal density of $\sqrt{b_1}$ a gamma density for the conditional distribution of b_2. Equiprobability contours are given for sampling from normal and nonnormal populations. In the normal case, an eight-parameter model is completely specified. 4 figures, 4 tables.

11404 **Summing asymptotic moment series.** Bowman, K.O.; Shenton, L.R. pp 121-125 of In Proceedings of the American Statistical Association. Boston; American Statistical Association (1976).

Summing techniques basically involve setting up rational fractions (in n, the sample size) whose asymptotic expansion coincides with a set of the series coefficients. Various aspects of the Pade approximation are illustrated, and a technique based on the Borel

method for summing strongly divergent series is described. 1 table. (RWR)

INFORMATION HANDLING

11405 (CONF-770525—, pp 30-46) **Care and feeding of data bases.** Ruebel, C.G. 1977.

From 16. AESOP conference; Seattle, Washington, USA (2 May 1977).

In Proceedings: AESOP conference. Volume 16.

The establishment of a data base management group at Rocky Flats and its operation are recalled. A number of past policies which did not give satisfactory results are listed. Analysis of these policies led to the following conclusions: the relationship between data elements must be analyzed to build well-structured data bases; data redundancy isn't always where one expects it; common programs should update all data bases; data bases are easier to expand. Benefits obtained from the data base approach include reduced data redundancy, reduced operating costs, reduced programing costs, reduced turnaround time, and improved service to users. It was found to be important to place the responsibility for design of the physical file structure of a data base system on a single data base administrator. These responsibilities included the following: define the content and structure of the data base; provide for the recovery of the data base in the event of failure; control the data access and search techniques to the data base; establish data-naming conventions and standards of data base documentation; establish views of the data base for information retrieval software; control the integrity of the data base; consult with analysts and users on the most effective use of the data base management system; and provide for the data base-oriented education of both the Data Base group and the application systems area. In conclusion, the importance of a data element dictionary is stressed. (RWR)

11406 (CONF-770525—, pp 103-113) **ERDA inter-laboratory working group for data exchange.** Austin, D.M. (Univ. of California, Berkeley). 1977.

From 16. AESOP conference; Seattle, Washington, USA (2 May 1977).

In Proceedings: AESOP conference. Volume 16.

The IWGDE is an "informal" collaboration of researchers from eight ERDA laboratories and ERDA Headquarters which "confers" several times weekly on problems associated with the acquisition and dissemination of data bases and modeling programs used in environmental impact analysis and energy policy studies. Collaboration is illustrated by reference to the study of populations at risk to air pollution. The history, development, and accomplishments of the IWGDE are summarized. The importance of collaboration among laboratories when new problems arise is pointed out. 1 fig., 1 table. (RWR)

11407 (CONF-771062—2) **Rationale of a standard interchange format.** Brooks, A.A. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 5p. Dep. NTIS, PC A02/MF A01.

From OECD/NEA working group on nuclear information; Berkeley, California, USA (5 Oct 1977).

The proposed draft American National Standard Specifications for a Data Descriptive File for I nformation Interchange, which is in development by the ANSI/X3L5 committee, is described. The standard is suited for R and D data interchange in an ASCII character mode.

11408 (NBS-SP—468, pp 121-130) **ERDA information center for failure prevention in fossil energy plants.** Smith, J.H.; Willard, W.A. Apr 1977.

From Preventation of failures in coal conversion systems; Columbus, Ohio, USA (21 Apr 1976).

In MFPG prevention of failures in coal conversion systems.

The ERDA Fossil Energy Failure Prevention System is a centralized system for collecting, evaluating, and disseminating information about operating experiences and component failure experiences in coal conversion pilot plants. The objectives of this program are to assist plant operating and design personnel in preventing plant shutdowns and in extending the useful life and reliability of plant components. Centralized coordination of the failure prevention activities will ensure that adequate and accurate diagnostic failure analyses are conducted and will enable the identification of significant and recurring problem areas common to many coal conversion pilot plants. This will provide a means of sharing and exchanging information between pilot plants about component failure problems and successful corrective measures to prevent future problems. The National Bureau of Standards is responsible for collecting and evaluating all detailed information from the pilot plants and from laboratories conducting diagnostic failure analyses. This information is stored and catalogued according to coal conversion process, material type, failure category, and component type so that the information is readily accessible. The information will be made available to operating and design personnel through direct contact with the Failure Prevention Information Center and through published reports describing specific problem areas and recommended corrective measures in coal conversion pilot plants.

CIVILIAN DEFENSE

11409 (UCRL—52316) **Strategic options: the frozen debate.** Gustavson, M.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Aug 1977. Contract W-7405-ENG-48. 14p. Dep. NTIS, PC A02/MF A01.

The strategic posture of the United States is briefly reappraised in terms of recent trends, actions being advocated, and the history of national security decisions. A differentiation is suggested between two approaches to deterrence, labeled "static" and "dynamic." Examples are cited. As a result of this perspective, new opportunities for choice are identified that may provide a basis for consensus and change.

CORPORATE INDEX

In the corporate index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate heading gives the report title and the volume and abstract numbers. Report numbers, if applicable, are given in parentheses at the end of the entry.

DOE Energy Information Data Base: Corporate Author Entries (TID-4585) is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

A

Abcor, Inc., Wilmington, Mass. (USA). Walden Div.
Research on cross-flow filtration for solids removal from coal syncrudes. Quarterly technical progress report, September 1—November 30, 1976, 3:9617 (FE—2245-9)

Ad Hoc Committee on the Use of Hydrogen for Natural Gas Supplementation (USA)
Evaluation of the use of hydrogen as a supplement to natural gas, 3:10603 (TID—27747)

Air Force Aero-Propulsion Lab., Wright-Patterson AFB, Ohio (USA)
Electrochemistry of some new alkaline battery electrodes, 3:10516 (AD-A—022952/6ST)

Air Products and Chemicals, Inc., Allentown, Pa. (USA). Corporate Research Dept.
Chemical characterization, handling, and refining of SRC to liquid fuels. Quarterly progress report, January—March 1977, 3:9611 (FE—2003-21)

Air Products and Chemicals, Inc., Marcus Hook, Pa. (USA)
Hot low Btu producer gas desulfurization in fixed bed of iron oxide-fly ash. Final report, 1 July 1975—30 April 1977. Volume II. Appendices A, B, C, D, and E, 3:9537 (FE—2033-19(Vol.2))

American Gas Association, Arlington, Va. (USA). Committee on Underground Storage
Underground storage of gas in the United States and Canada. Twenty-sixth annual report on statistics of the Committee on Underground Storage, 3:9712 (NP—22484)

AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.
Diffusion of stellarator magnetic fields into hollow circular cylinders, 3:11309 (KFTI—75-21)
Parametric excitation of potential waves in a cold inhomogeneous plasma, 3:11271 (KFTI—76-17)
Turbulent current heating of dense plasma, 3:11183 (KFTI—76-7)

Argonne National Lab., Ill. (USA)
Advanced Fuels Program. Quarterly progress report for the period, July—September 1974, 3:10427 (ANL-AFP—1)
Advanced fuels program. Quarterly progress report, October—December 1977, 3:10195 (ANL-AFP—34)
Advanced fuels program. Quarterly progress report, January—March 1977, 3:10196 (ANL-AFP—35)
Dynamic instability analysis of axisymmetric shells by finite element method with convected coordinates, 3:10200 (CONF-770807—34)
Instrumentation and process control for fossil demonstration plants. Quarterly technical progress report, January—March 1977, 3:9544 (ANL-FE—49622-6)
Instrumentation and process control for fossil demonstration plants. Monthly technical progress report, August 1977, 3:9545 (ANL-FE—49622-11)
Long-lived particle spectrometer for the Fermilab collider, 3:10877 (ANL-HEP-PR—77-53)
Numerical results obtained from the three dimensional transient single phase version of the COMMIX computer code, 3:10428 (ANL-CT—78-3)
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Quantative determination of surface temperatures using an infrared camera, 3:10623 (CONF-770868—2)
Reactor development program progress report, July—August 1977, 3:10429 (ANL-RDP—62)
Response of subassembly model with internals, 3:10431 (CONF-770807—46)
Study of the volatility of minor and trace elements in Illinois coal, 3:9638 (ANL/CEN/FE—77-4)
Subsonic MHD-diffuser performance with high blockage, 3:10617 (CONF-770530—1)
Two-dimensional subsonic diffuser code, 3:10616 (ANL/MHD—77-1)

Army Engineer Div., Huntsville, Ala. (USA)
Fischer—Tropsch design project capital cost validation, 3:9610 (FE—1759-2)
Oil-Gas Plant Design Project capital cost validation, 3:9553 (FE—1759-1)

Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee
Asymptotic method in the nonlinear theory of coherent Langmuir waves, 3:11266 (EUR-CEA-FC—864(Pts.1-2))
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Electron temperature and Zsub(eff) measurements in hot plasmas by soft x-ray analysis, 3:11200 (EUR-CEA-FC—836)
Oxygen gas injection during the current plateau of a T.F.R. Tokamak plasma, 3:11182 (EUR-CEA-FC—868)
Recent results on plasma-wall interaction in the T.F.R. Tokamak, 3:11301 (EUR-CEA-FC—875)
Transition probabilities for argon I, 3:11199 (EUR-CEA-FC—835)
Weakly turbulent kinetic theory of the electromagnetic ion-cyclotron instability. Initial noise and quiet start (Q.S.) in electromagnetic particle simulation codes, 3:11241 (EUR-CEA-FC—874)

Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Groupe de Recherches sur la Fusion Controlee
Impurity diffusion in Tokamaks in mixed regimes, 3:11220 (EUR-CEA-FC—879)
Scattering of radiation from cyclotron harmonic oscillators, 3:11202 (EUR-CEA-FC—878)

Atomic Energy Board, Pelindaba, Pretoria (South Africa)
Environment of deposition and stratigraphy of the uranium-bearing strata around Beaufort West, South Africa, 3:9719 (PEL—251)

Atomics International Div., Canoga Park, Calif. (USA)
Molten Salt Coal Gasification Process Development Unit. Quarterly technical progress report No. 3, October—December 1976, 3:9565 (FE—2342-12)
Vibration tests of a full scale water model of a Clinch River steam generator module, 3:10211 (TID—27821)
Atomics International Div., Golden, Colo. (USA). Rocky Flats Plant
Statistical tests for locating power in a Fourier line spectrum, 3:10756 (RFP—2482)

B

Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.
1/3 scale air—water pump program, analytical pump performance model. Volume 1. Key phase report, 3:10433 (EPRI-NP—160(Vol.1))
Battelle Columbus Labs., Ohio (USA)
Agglomerating Burner Gasification Process. Design, installation, and operation of a 25-ton-a day Process Development Unit. Quarterly report, April—June 1977, 3:9549 (FE—1513-62)
Radiological environmental assessment of the recycle of LMFBR advanced fuels, 3:9821 (CONF-771008—5)
Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.)
Heating costs and problems of renting. Prospects on future requirements on the housing market, 3:10555 (AED-CONF—77-027-006)
Battelle Pacific Northwest Labs., Richland, Wash. (USA)
324 building safety analysis report supplement, 3:9775 (BNWL-CC—2028(Suppl.1))
Description and comparison of energy impact assessment models, 3:10980 (BNWL—2107)
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User's manual for the BNW-I optimization code for dry-cooled power plants. Volume III, 3:10058 (BNWL—2180(Vol.3))
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Baylor Univ., Houston, Tex. (USA). Coll. of Medicine
Algorithm for nonparametric density estimation, 3:11397 (ORO—5046-5)
Bechtel Corp., San Francisco, Calif. (USA)
Analysis of coal hydrogasification processes. Monthly technical progress report, August 1—31, 1977, 3:9575 (FE—2565-4)
Effect of plant size on the cost of producing industrial gas in small fixed bed gasifiers, 3:9576 (FE/WAPO/0020—1)
Effect of plant size on the cost of producing industrial gas, 3:9577 (FE/WAPO/2526—1)
Bendix Corp., Kansas City, Mo. (USA)
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Krypton-85 enrichment by adsorption-desorption process, 3:9774 (BARC—859)
Bosch (R.) G.m.b.H., Wernau (Germany, F.R.)
Heat pumps for outer air, 3:10621 (AED-Conf—77-053-003)
Boston Coll., Weston, Mass. (USA). Weston Observatory
Pennsylvanian coal-bearing strata of the Narragansett Basin, 3:9658 (NSF/RA—76-0337)
Braun (C.F.) and Co., Alhambra, Calif. (USA)
Quarterly technical progress report, April—June 1977, 3:9561 (FE—2240-71)
Brigham Young Univ., Provo, Utah (USA)
Acquisition of the ANL 4-MeV electrostatic accelerator. Progress report, September 1, 1976—August 31, 1977, 3:10860 (COO—1805-4)
Brigham Young Univ., Provo, Utah (USA). Dept. of Chemical Engineering
Mixing and gasification of coal in entrained flow systems. Final report, November 29, 1974—April 30, 1977, 3:9554 (FE—1767-9)
Brookhaven National Lab., Upton, N.Y. (USA)
Energy systems analysis and development, 3:10552 (BNL—22969)
Environmental critique of solar power by bioconversion methods, 3:9927 (BNL—21955)
Flash hydropyrolysis of coal. Quarterly report No. 1, January 1—March 31, 1977, 3:9541 (BNL—50677)
Monitoring of radioiodine from containment accidents, 3:10919 (BNL—23112)
Planner's energy workbook: a manual for exploring relationships between land use and energy utilization, 3:10551 (BNL—50633)
Brooklyn Coll., N.Y. (USA). Dept. of Chemistry
Nuclear and radiochemical techniques in chemical analysis. Progress report, August 1, 1976—July 31, 1977, 3:10723 (COO—3126-37)
Brown Univ., Providence, R.I. (USA). Div. of Engineering
Effect of seasonal variations of ambient temperatures on the performance of low temperature power cycles, 3:10024 (COO—4051-10)
Bundesanstalt fuer Geowissenschaften und Rohstoffe, Hannover (Germany, F.R.)
Heat of the Earth as a source of energy, 3:9995 (NP—22645)
Bureau de Recherches Geologiques et Minieres (BRGM), 45 - Orleans (France)
Geothermal energy, 3:9994 (NP—22486)
Geothermal energy operations and objectives of the B.R.G.M. (76 SGN 519 GTH), 3:10017 (NP—22494)
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The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

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CONF-751183-		(2. seminary of the commission for Europe (United Nations) for the desulfurization of fuel and stack gas, Washington, District of Columbia, USA, 11-20 Nov 1975)
1	3:9648	*See* ENV/SEM-4/Cb.3
CONF-7511137-		(6. C. C. Furnas Memorial Conference, Buffalo, New York, USA, Nov 1975)
	3:10651	Marcel Dekker, Inc. (1977).
CONF-760160-		(Meeting of the Institute of Geophysics, Hamburg, F.R. Germany, 22 Jan 1976)
1	3:9992	Dep. NTIS (US Sales Only), PC A03/MF A01
CONF-760241-		(Symposium on power plants dynamics and control, Trombay, India, 23-24 Feb 1976)
	3:10368	
CONF-760472-		(Preventation of failures in coal conversion systems, Columbus, Ohio, USA, 21-23 Apr 1976)
	3:9578	*See* NBS-SP-468
CONF-7604139-		(1. international petrochemical conference, San Antonio, Texas, USA, 4-6 Apr 1976)
4	3:10597	*See* IPC-76-41
CONF-760560-		(3. international conference on nuclides far from stability, Corsica, Italy, 19-26 May 1976)
	3:11124	*See* CERN-76-13
CONF-760567-		(Workshop on the determination of momentum wavefunctions, Bloomington, Indiana, USA, 31 May-4 Jun 1976)
	3:11067	American Institute of Physics (1977).
CONF-7605160-		(1. symposium on management of residuals from synthetic fuels production, Denver, Colorado, USA, 25-27 May 1976)
	3:9646	Univ. of Denver
CONF-7605161-		(Annual engineering conference, Townsville, Australia, 10-14 May 1976)
	3:10752	Institution of Engineers, Sydney, Australia
CONF-7605168-		(55. annual meeting of Japan Electric Association, Tokyo, Japan, May 1976)
2	3:9993	TIC
CONF-760646-		(Symposium on uranium plasmas, Princeton, New Jersey, USA, 10-12 Jun 1976)
	3:11217	
CONF-760678-		(Meeting of the Society of Automotive Engineers on combined fuels and powerplant, St. Louis, Missouri, USA, 8-10 Jun 1976)
6	3:10671	Society of Automotive Engineers (1976).
8	3:10662	Society of Automotive Engineers (1976).
9	3:10672	Society of Automotive Engineers (1976).
10	3:10673	Society of Automotive Engineers (1976).
11	3:10675	Society of Automotive Engineers (1976).
12	3:10674	Society of Automotive Engineers (1976).
13	3:10666	Society of Automotive Engineers (1976).
14	3:10667	Society of Automotive Engineers (1976).
15	3:10663	Society of Automotive Engineers (1976).
16	3:10676	Society of Automotive Engineers (1976).
17	3:10677	Society of Automotive Engineers (1976).
CONF-760850-		(Proceedings of the International Society for Experimental Hematology, Washington, District of Columbia, USA, 17-21 Aug 1976)
	3:10984	Springer-Verlag (1977).
CONF-760895-		(3. national conference on the effects of energy constraints on transportation systems, Schenectady, New York, USA, 2-6 Aug 1976)
	3:10618	Dep. NTIS, PC A17/MF A01
CONF-761049-		(International symposium on plasma wall interaction, Julich, F.R. Germany, 18-22 Oct 1976)
10	3:11301	*See* EUR-CEA-FC-875
CONF-761057-		(Electrochemical Society meeting, Las Vegas, Nevada, USA, 17-22 Oct 1976)
(Absts.)	3:10745	Electrochemical Society (1976).
CONF-7610118-		(Photovoltaics power conditioning workshop, Albuquerque, New Mexico, USA, 13-14 Oct 1976)
	3:9919	*See* SAND-77-0393
CONF-7610135-		(KTG technical day on fuel element of the sodium-cooled breeder, Karlsruhe, F.R. Germany, 28-29 Oct 1976)
	3:10204	*See* KFK-2416
CONF-761117-		(NASA-JPL conference on charge coupled device technology and applications, Washington, District of Columbia, USA, 30 Nov-2 Dec 1976)
	3:10848	*See* N-77-14540
CONF-761129-		(Terrestrial PV measurements workshop, Baton Rouge, Louisiana, USA, 10-12 Nov 1976)
	3:9866	*See* ERDA/NASA-1022/76/10
CONF-761184-		(Workshop on global chemical cycles and their alterations by man, Berlin, F.R. Germany, 15-19 Nov 1976)
	3:10909	Abakon Verlagsgesellschaft (1977).
CONF-761189-		(VGB specialists meeting on steam turbines and steam turbine operation, Hamburg, F.R. Germany, 12 Nov 1976)
1	3:10064	*See* AED-Conf-76-595-004
CONF-770124-		(Conference of the Orbis Scientiae Center for Theoretical Studies, Coral Gables, Florida, USA, 16-21 Jan 1977)
4	3:11076	*See* LBL-6147
CONF-770236-		(2. international fair and congress on techniques in environmental protection, Duesseldorf, F.R. Germany, 8-10 Feb 1977)
2	3:10609	*See* AED-CONF-77-002-007
CONF-770241-		(Conference on the role of energy in food production, Pacific Grove, California, USA, 6-11 Feb 1977)
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CONF-770312-		(Annual AIME meeting, Atlanta, Georgia, USA, Mar 1977)
P1	3:10739	American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1977).
CONF-770313-		(Particle accelerator conference, Chicago, Illinois, USA, 16-18 Mar 1977)
74	3:10864	*See* LBL-5540
CONF-770317-		(22. ASME international turbine conference, Philadelphia, Pennsylvania, USA, 27-31 Mar 1977)
4	3:10153	*See* GA-A-13973
CONF-770326-		(Western regional strain gage committee meeting, San Jose, California, USA, 3-4 Mar 1977)
1	3:10873	*See* LBL-6161
CONF-770377-		(134. meeting of the Haus der Technik e.V. on non-conventional energy carriers, Essen, F.R. Germany, 21-22 Mar 1977)
1	3:10610	*See* AED-CONF-77-053-001
2	3:10621	*See* AED-Conf-77-053-003
3	3:10620	*See* AED-Conf-77-053-002
CONF-770378-		(3. meeting of the Deutsche Gesellschaft fuer Sonnenenergie e.V. on heating with sun 2 - house technology under practical aspects, Munich, F.R. Germany, 3-4 Mar 1977)
1	3:10650	*See* AED-Conf-77-027-001
6	3:10555	*See* AED-CONF-77-027-006
CONF-770430-		(4. international symposium on automotive propulsion systems, Washington, District of Columbia, USA, 17-22 Apr 1977)
3	3:10661	*See* UCRL-79153
CONF-770460-		(Spring meeting of the Mining and Metallurgical Institute of Japan, Tokyo, Japan, Apr 1977)
6	3:10981	*See* COO-2314-12
CONF-770525-		(16. AESOP conference, Seattle, Washington, USA, 2-5 May 1977)
	3:11374	Dep. NTIS, PC A08/MF A01

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CONF-770530-		(16. engineering aspects of MHD symposium, Pittsburgh, Pennsylvania, USA, 16-18 May 1977)
1	3:10617	Dep. NTIS, PC A02/MF A01
CONF-770559-		(Expert conference, Oslo, Norway, 11-13 May 1977)
2	3:10981	*See* COO-2314-12
CONF-770585-		(Meeting on the application of energy at the final consumption stage - analysis, planning, techniques, Schliersee, F.R. Germany, 17-18 May 1977)
2	3:10622	*See* AED-CONF-77-072-006
CONF-770595-		(DAMSUL committee meeting, Las Vegas, Nevada, USA, 18-19 May 1977)
1	3:10772	*See* UCRL-80122
CONF-7705100-		(Navajo nation energy conference, Tsaile, Arizona, USA, 2 May 1977)
	3:10561	*See* LA-6927-C
CONF-770625-		(International conference on nuclear systems reliability engineering and risk assessment, Gatlinburg, Tennessee, USA, 20-24 Jun 1977)
4	3:10438	*See* GA-A-14336
CONF-770632-		(Conference on cogeneration and integral energy/utility systems, Washington, District of Columbia, USA, 3 Jun 1977)
	3:10582	Dep. NTIS, PC A10/MF A01
CONF-770641-		(Conference on radiation effects in breeder reactor structural materials, Scottsdale, Arizona, USA, 19-23 Jun 1977)
13	3:10202	*See* HEDL-SA-1175
CONF-770644-		(EPRI review meeting on advanced fuel fusion, Chicago, Illinois, USA, 27-28 Jun 1977)
	3:11317	*See* EPRI-ER-536-SR
CONF-770655-		(Coal feeding systems conference, Pasadena, California, USA, 21-23 Jun 1977)
3	3:9603	Dep. NTIS, PC A02/MF A01
CONF-770689-		(SIMS conference on statistical analysis of ecological processes in time and space, Alta, Utah, USA, 27 Jun-1 Jul 1977)
	3:11376	Dep. NTIS, PC A04/MF A01
CONF-770692-		(International conference on stochastic behavior and quantum hamiltonian systems, Tremezzo, Italy, 20-24 Jun 1977)
2	3:11180	*See* UCRL-80094
CONF-770720-		(22. annual meeting of the Health Physics Society, Atlanta, Georgia, USA, 3-8 Jul 1977)
5	3:10919	*See* BNL-23112
CONF-770740-		(AESOP operations managers conference, Arlington, Virginia, USA, 11-13 Jul 1977)
	3:11377	Dep. NTIS, PC A12/MF A01
CONF-770741-		(NATO summer institute on coupled plasmas, Orleans, France, 7-23 Jul 1977)
1	3:11225	*See* UCRL-80119
CONF-770742-		(Workshop on systems development, Seoul, Republic of Korea, 12-15 Jul 1977)
1	3:10552	*See* BNL-22969
CONF-770747-		(EPRI geothermal program progress report and Geothermal Milestones, Kah-nee-ta, Oregon, USA, 25-28 Jul 1977)
1	3:9991	*See* LBL-6826
CONF-770807-		(4. international conference on structural mechanics in reactor technology, San Francisco, California, USA, 15-19 Aug 1977)
34	3:10200	Dep. NTIS, PC A02/MF A01
46	3:10431	Dep. NTIS, PC A02/MF A01
CONF-770813-		(ADINA conference, Cambridge, Massachusetts, USA, 4-5 Aug 1977)
2	3:10867	*See* LA-UR-77-1320
CONF-770814-		(American Chemical Society meeting, Chicago, Illinois, USA, 29 Aug-2 Sep 1977)
8	3:10742	Dep. NTIS, PC A02/MF A01
CONF-770821-		(EMSA meeting, Boston, Massachusetts, USA, Aug 1977)
2	3:9641	*See* IS-4251
CONF-770848-		(IEEE non-volatile semiconductor memory workshop, Vail, Colorado, USA, 23-25 Aug 1977)
1	3:10881	*See* SAND-77-0870C
CONF-770857-		(6. world congress of psychiatry, Honolulu, Hawaii, USA, 28 Aug-3 Sep 1977)
1	3:10981	*See* COO-2314-12
CONF-770863-		(Chemical industry institute of toxicology workshop on strategies for short-term testing for Mutagens/Carcinogens, Research Triangle Park, North Carolina, USA, 11-12 Aug 1977)
1	3:10986	Dep. NTIS, PC A03/MF A01
CONF-770868-		(21. annual technical symposium of the Society of Photo-Optical Instrumentation, San Diego, California, USA, 22-26 Aug 1977)
2	3:10623	Dep. NTIS, PC A02/MF A01
CONF-770902-		(Specialists meeting on reactor noise, Gatlinburg, Tennessee, USA, 19-23 Sep 1977)
5	3:10095	Dep. NTIS, PC A02/MF A01
CONF-770908-		(7. international Vac. congress and 3. international conference on solid surfaces, Vienna, Austria, 12-16 Sep 1977)
6	3:11066	Dep. NTIS, PC A02/MF A01
CONF-770929-		(Seminar on HTGR safety technology, Upton, New York, USA, 15-16 Sep 1977)
1	3:10156	*See* LA-UR-77-1992
4	3:10440	*See* LA-UR-77-1993
5	3:10207	*See* LA-UR-77-1956
CONF-770931-		(7. international conference on atomic collisions in solids, Moscow, F.R. Germany, 19-23 Sep 1977)
2	3:11047	Dep. NTIS, PC A02/MF A01
CONF-770935-		(5. international conference on vacuum ultraviolet radiation physics, Montpellier, France, 5-9 Sep 1977)
2	3:10883	Dep. NTIS, PC A02/MF A01
CONF-770939-		(3. power plant dynamics, control and testing symposium, Knoxville, Tennessee, USA, 7-9 Sep 1977)
1	3:10656	Dep. NTIS, PC A02/MF A01
CONF-770945-		(11. European conference on laser interaction with matter, Oxford, UK, 19-23 Sep 1977)
3	3:11351	*See* UCRL-79816
4	3:11352	*See* UCRL-79819
CONF-770947-		(CECAM meeting on models for transport phenomena in laser fusion plasmas, Menton, France, 5-9 Sep 1977)
1	3:11352	*See* UCRL-79819
CONF-770950-		(26. meeting of the international union of pure and applied chemistry, Tokyo, Japan, 4-12 Sep 1977)
1	3:10720	*See* LBL-6742
CONF-770958-		(American Ceramic Society fall meeting, Hyannis, Massachusetts, USA, 26-28 Sep 1977)
1	3:10203	*See* HEDL-SA-1268
CONF-770968-		(International conference on nuclear structure, Tokyo, Japan, 5-10 Sep 1977)
4	3:11152	*See* LBL-6592
CONF-771003-		(CONRT'S improved conversion efficiency workshop, Pipestem, West Virginia, USA, 16-18 Oct 1977)
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CONF-771008-		(International meeting on advanced LMFBR fuels, Tucson, Arizona, USA, 10-13 Oct 1977)
5	3:9821	Dep. NTIS, PC A02/MF A01
CONF-771015-		(Fall meeting of the Western States Section of the Combustion Institute, Palo Alto, California, USA, 17-18 Oct 1977)
6	3:10668	*See* LBL-6841
CONF-771023-		(Nuclear science symposium, San Francisco, California, USA, 19-21 Oct 1977)
5	3:11393	*See* LA-UR-77-2383
7	3:10989	*See* LA-UR-77-2409
CONF-771029-		(7. symposium on fusion research project, Knoxville, Tennessee, USA, 25-29 Oct 1977)
1	3:11310	*See* UCRL-79744
CONF-771035-		(2. international topical conference, Ithaca, New York, USA, 3-5 Oct 1977)
2	3:10793	*See* SAND-77-1283c
4	3:10866	*See* SAND-77-1551C
8	3:10868	*See* LA-UR-77-2205
10	3:10865	*See* SAND-77-1282C
CONF-771036-		(2. ASTM-EURATOM symposium on reactor dosimetry: dosimetry methods for fuels, cladding and structural materials, Palo Alto, California, USA, 2-7 Oct 1977)
1	3:11125	*See* LA-UR-77-2140
CONF-771037-		(ERDA contractors' coordination meeting, Detroit, Michigan, USA, 4 Oct 1977)
1	3:10664	*See* SAND-77-8270

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2	3:10749	*See* ORO-4447-061
CONF-771040-		(Electro-Optical systems conference, Anaheim, California, USA, 25-27 Oct 1977)
5	3:10740	*See* LA-UR-77-2222
CONF-771041-		(13. annual gaseous electronic conference, Stanford, California, USA, 18-21 Oct 1977)
1	3:11211	*See* UCRL-79953
CONF-771052-		(International working group on fast reactors (IAEA/IWGFR) specialists meeting, Bensburg, F.R. Germany, 17-21 Oct 1977)
1	3:10201	Dep. NTIS, PC A03/MF A01
CONF-771053-		(Flywheel technology symposium, San Francisco, California, USA, 5-7 Oct 1977)
4	3:10493	*See* Y/DA-7291
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2	3:11407	Dep. NTIS, PC A02/MF A01
CONF-771104-		(11. annual ASILOMAR conference on circuits, systems, and computers, Pacific Grove, California, USA, 7-9 Nov 1977)
3	3:11394	*See* LA-UR-77-2521
CONF-771108-		(Post accident heat removal information exchange meeting, Chicago, Illinois, USA, 2-3 Nov 1977)
3	3:10432	Dep. NTIS, PC A02/MF A01
CONF-771109-		(ANS winter meeting, San Francisco, California, USA, 27 Nov-2 Dec 1977)
30	3:9838	*See* SAND-77-1084C
34	3:9843	*See* SAND-77-1083C
CONF-771120-		(Winter annual meeting of the American Society of Mechanical Engineers, Atlanta, Georgia, USA, 27 Nov-2 Dec 1977)
4	3:9985	*See* COO-2923-3
CONF-771125-		(3. international conference of environmental problems of the extractive industries-materials, energy and environment, Dayton, Ohio, USA, 29 Nov-1 Dec 1977)
1	3:9836	*See* MLM-2474(OP)
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1	3:9854	*See* UCRL-80282
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5	3:10852	*See* SAND-77-1295C
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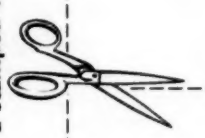

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